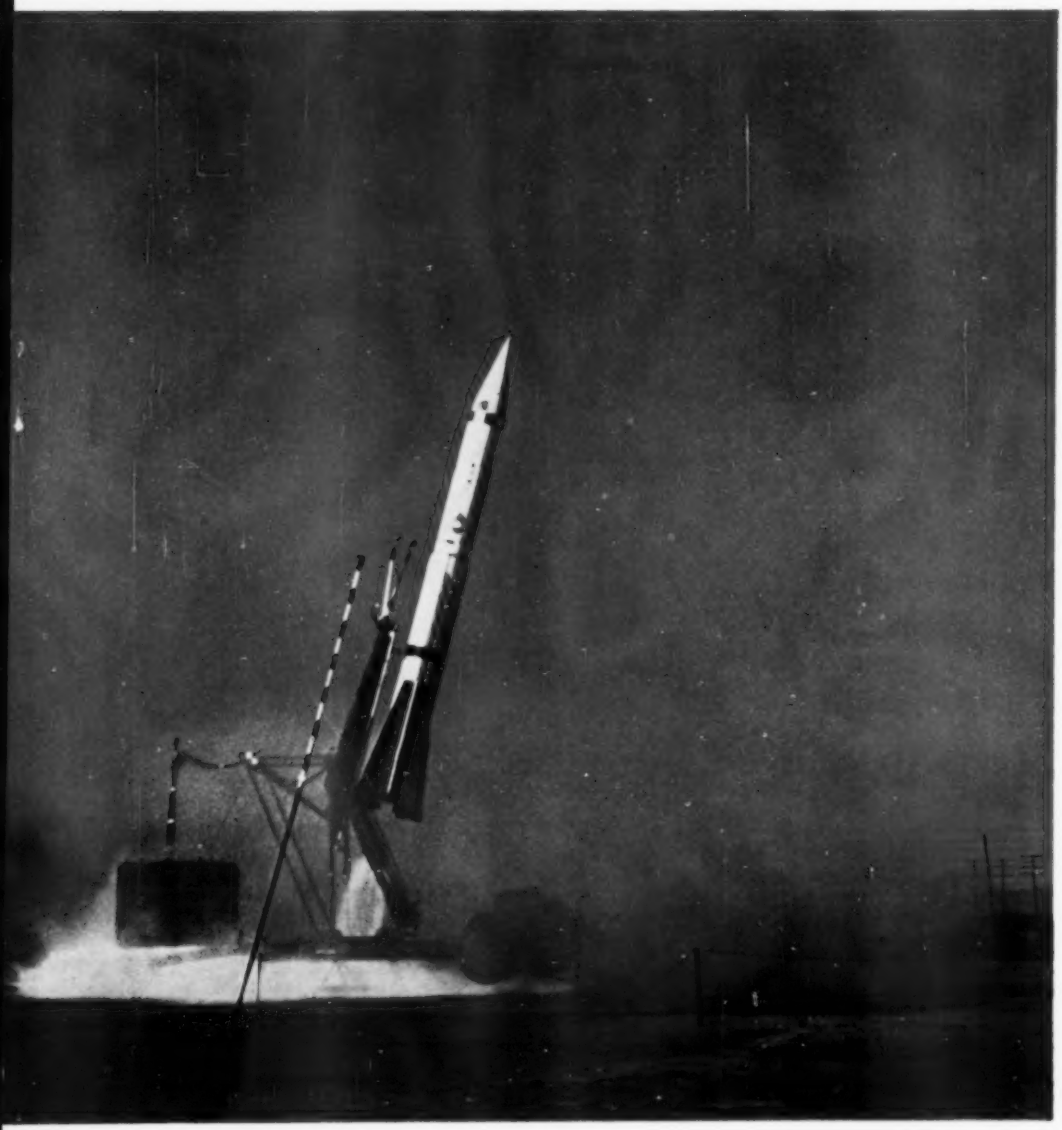
ORDNANCE

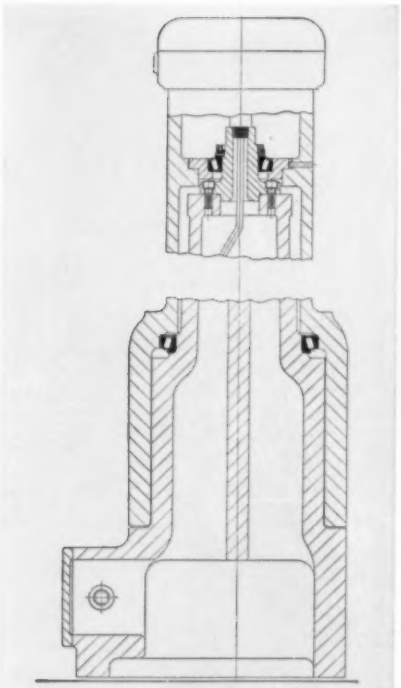
LAND • SEA • AIR AND SPACE WEAPONS



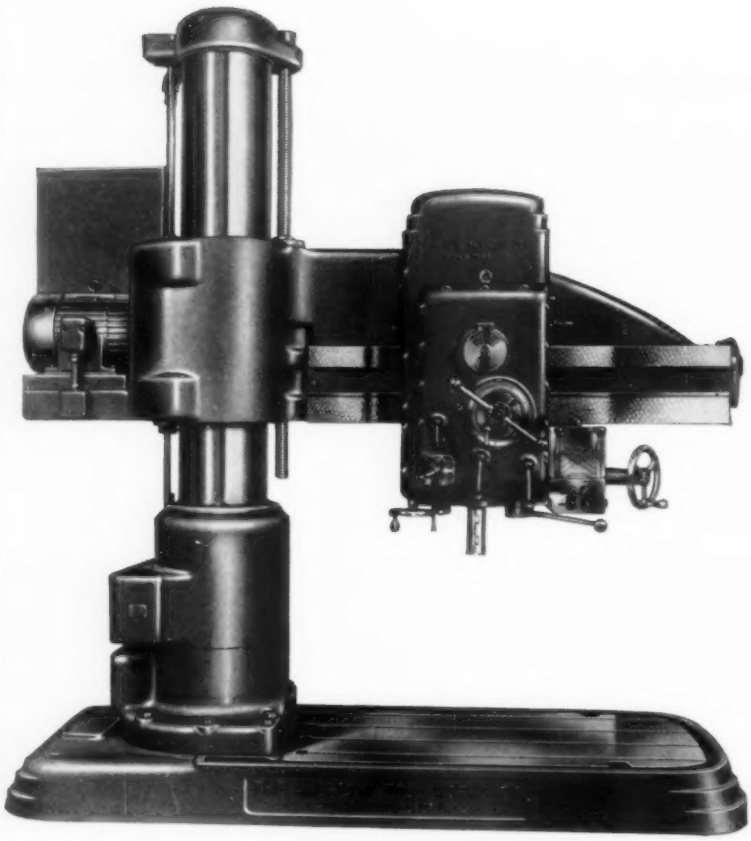
Solid Propellant Sergeant

MAY-JUNE 1958

SPECIAL PICTORIAL REPORT ON OUR FIGHTING SHIPS....PAGE 985



How **THE AMERICAN TOOL WORKS CO.** mounts column of 32-speed Hole Wizard Radial on 2 Timken bearings to increase rigidity 50%. Spindle and transmission use 11 more Timken bearings.



This radial drill has 50% more rigidity with column mounted on Timken® bearings

TO resist stresses and cut arm deflection in half, the column unit of this 32-speed Hole Wizard Radial is mounted on two Timken® tapered roller bearings. With a large, preloaded Timken bearing at top and bottom, The American Tool Works Company gives the column and sleeve the rigidity of a single piece. This results in greater accuracy and longer cutting tool life, permits higher speeds and coarser feeds.

HOW COLUMN IS HELD RIGID. Timken bearings keep the column unit in positive alignment. Their tapered design lets them take both thrust and radial loads in any combination. And full line contact between rollers and races gives Timken bearings load-carrying capacity to spare.

HEAVY SHOCKS ABSORBED. Rollers and races of Timken bearings are case-carburized to give them hard, wear-resistant surfaces over tough, shock-resistant cores. They reduce maintenance.

FRICTION VIRTUALLY ELIMINATED. Timken bearings run smoother, last longer, because they're geometrically designed for true rolling motion—and precision-made to live up to their design. We even make our own electric furnace, fine alloy steel—the only American bearing maker who does.

So whether you buy or build machines, it pays to specify bearings trademarked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN TAPERED ROLLER BEARINGS ROLL THE LOAD

TRADE-MARK REG. U. S. PAT. OFF.

ORDNANCE

LAND • SEA • AIR AND SPACE WEAPONS

The Magazine of Scientific and Industrial Preparedness Now in Its 38th Year

VOL. XLII MAY-JUNE 1958 NO. 228

The Cover.—*The Sergeant is the Army's new solid-propellant surface-to-surface guided missile. It can carry a nuclear warhead and can be emplaced quickly by a very small crew under any conditions of weather or terrain.*

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ARMAMENT TECHNOLOGY

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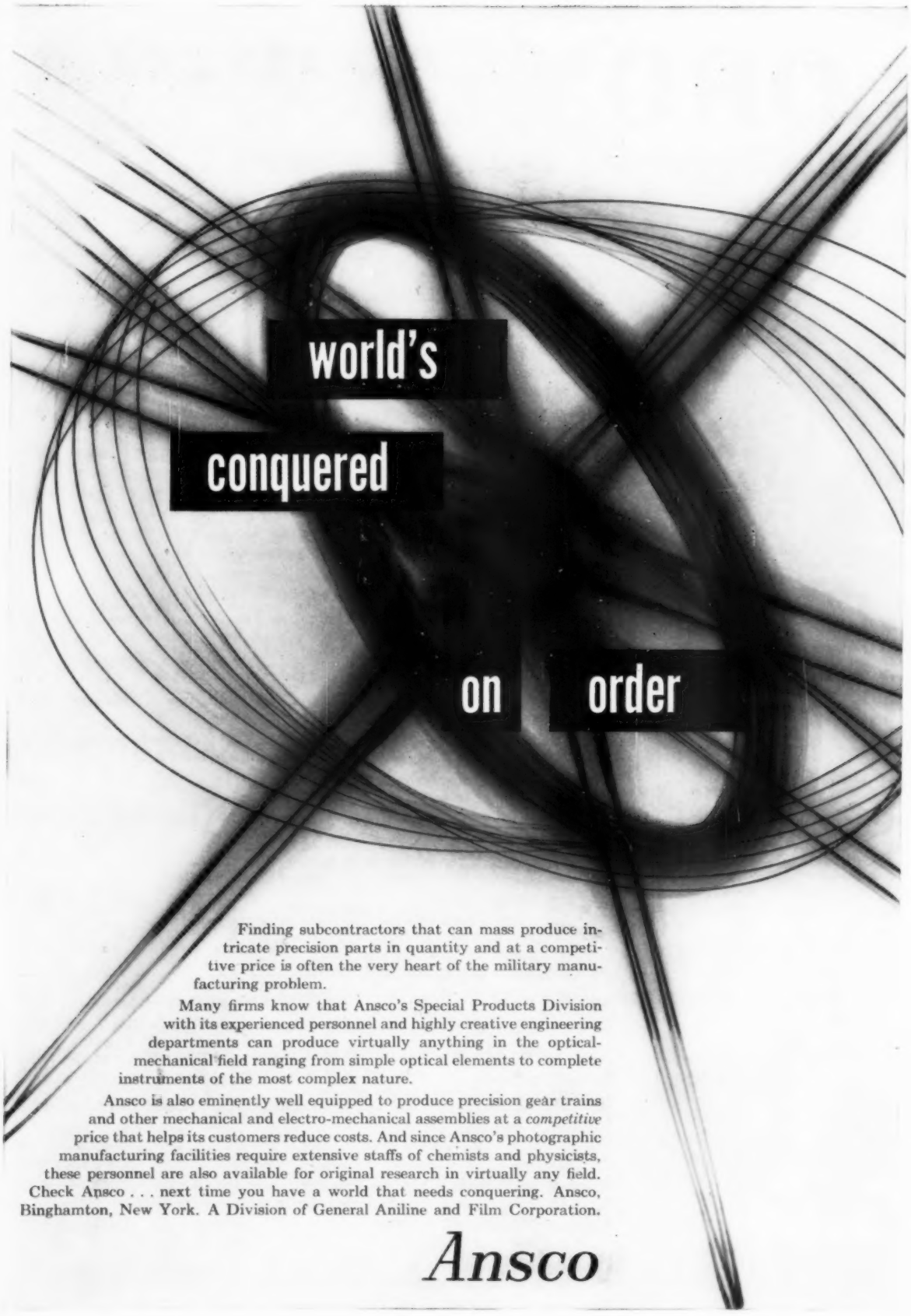


Finding subcontractors that can mass produce intricate precision parts in quantity and at a competitive price is often the very heart of the military manufacturing problem.

Many firms know that Ansco's Special Products Division with its experienced personnel and highly creative engineering departments can produce virtually anything in the optical-mechanical field ranging from simple optical elements to complete instruments of the most complex nature.

Ansco is also eminently well equipped to produce precision gear trains and other mechanical and electro-mechanical assemblies at a *competitive* price that helps its customers reduce costs. And since Ansco's photographic manufacturing facilities require extensive staffs of chemists and physicists, these personnel are also available for original research in virtually any field. Check Ansco . . . next time you have a world that needs conquering. Ansco, Binghamton, New York. A Division of General Aniline and Film Corporation.

Ansco

"COUNTING DOWN" as a Firestone Corporal Missile is Launched or— COUNTING UP many other Firestone products and services . . .

EIGHT
PLASTICS
SEVEN
TIRES & RUBBER PRODUCTS
SIX
TANK GUNS

Firestone

IS READY WITH PRODUCTS AND SERVICES FOR NATIONAL DEFENSE AND SECURITY

COUNTING DOWN, 10, 9, 8 . . . 4, 3, 2, 1, 0 is a common practice today and has come to mean the preamble to a missile launching. Missile launchings are in the news. Firestone is proud to have been active in the manufacture, engineering redesign, and successful field use of the Army's Corporal Missile, the first operational member of the family of rocket-powered ballistic surface-to-surface guided missiles capable of carrying an atomic warhead.

The Corporal missile, in the hands of the troops since 1953, can deliver supersonic, surprise devastation on targets which may be immune to attack by aircraft. The Corporal has a very significant role in the new pentomic concept of defense, deterrence of war, and if necessary, complete mobilization.

The Corporal project has given Firestone broad training in the development and production of weapons systems.

COUNTING UP 1, 2, 3, 4 . . . a long list of items can be enumerated which indicate by their variety and extent, the broad fields in which Firestone has operated, is now operating, and is capable of operating for and with the government.

It all **COUNTS UP** to the fact that Firestone is an organization skilled in many fields of endeavor for the national defense effort, whether thinking in terms of guided missiles or the many other classes of products and services required for maintenance of peace and security.

FIVE — GUIDED MISSILE LAUNCHING AND SUPPORT EQUIPMENT

FOUR — FUEL CELLS

THREE — JET ENGINE COMPONENTS

TWO — RADOMES

ONE — RECOILLESS WEAPONS AND AMMUNITION

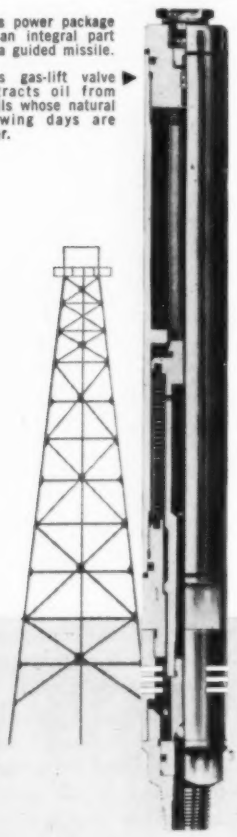
THE FIRESTONE TIRE & RUBBER COMPANY

Defense Products Division • Akron, Ohio

SUPERSONIC SUBSURFACE

▲ This power package is an integral part of a guided missile.

This gas-lift valve ▶ extracts oil from wells whose natural flowing days are over.



Both these products are examples of the management, engineering, research and production skills of U.S. Industries. Both are essential to American military and industrial strength.

The divisions that comprise USI produce *both* fire power and industrial power: from artillery shells, guided missile and aircraft components, to machine tools, storage tanks, electrical fittings, oil tools; steel pipe, giant metal forming presses. USI's newest division, the Kett Technical Center, performs research and development for both the armed forces and for industry.

The interdependence of military and industrial power is nowhere better exemplified than at U.S. Industries, a production team geared to American strength and progress.

For specific information about products in your particular field, *call or write:*

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WESTERN DESIGN & MANUFACTURING CORP.
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Is your tubing bottleneck shown here?

Bundy Engineers and versatile Bundyweld Tubing can beat the knottiest tubing design problem!

If you think it can't be done with tubing, it's a challenge to Bundy. For years, Bundy Engineers have specialized in working with customers and prospects, solving the insolvable. A unique combination of imagination and experience, plus the extreme versatility of Bundyweld Steel Tubing, has paid off again and again.

Check first with Bundy for workable solutions to your tubing design problems. Whether you are in the design, developmental, or application stage of your product, Bundy will be glad to work with you. Hundreds of manufacturers have used this Bundy service to advantage.

Bundyweld Tubing offers an unusual combination of properties: high thermal conductivity; high bursting strength; ease of fabrication; and thinner-walled, yet stronger composition. It is the safety standard of the refrigeration industry, and is used in 95% of today's cars, in an average of 20 applications each.

Call, write, or wire us today!

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN

Shown above are but a few of the fabrication operations which are possible with Bundyweld Steel Tubing. Many of these, and others not shown, were developed through solving a specific problem brought to us by a customer or prospect. Bundy invites you to avail yourself of this design service.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, ITALY, AND GERMANY

Bundyweld starts as a single strip of copper-coated steel. Then it's

. . . continuously rolled twice around laterally into a tube of uniform thickness and passed

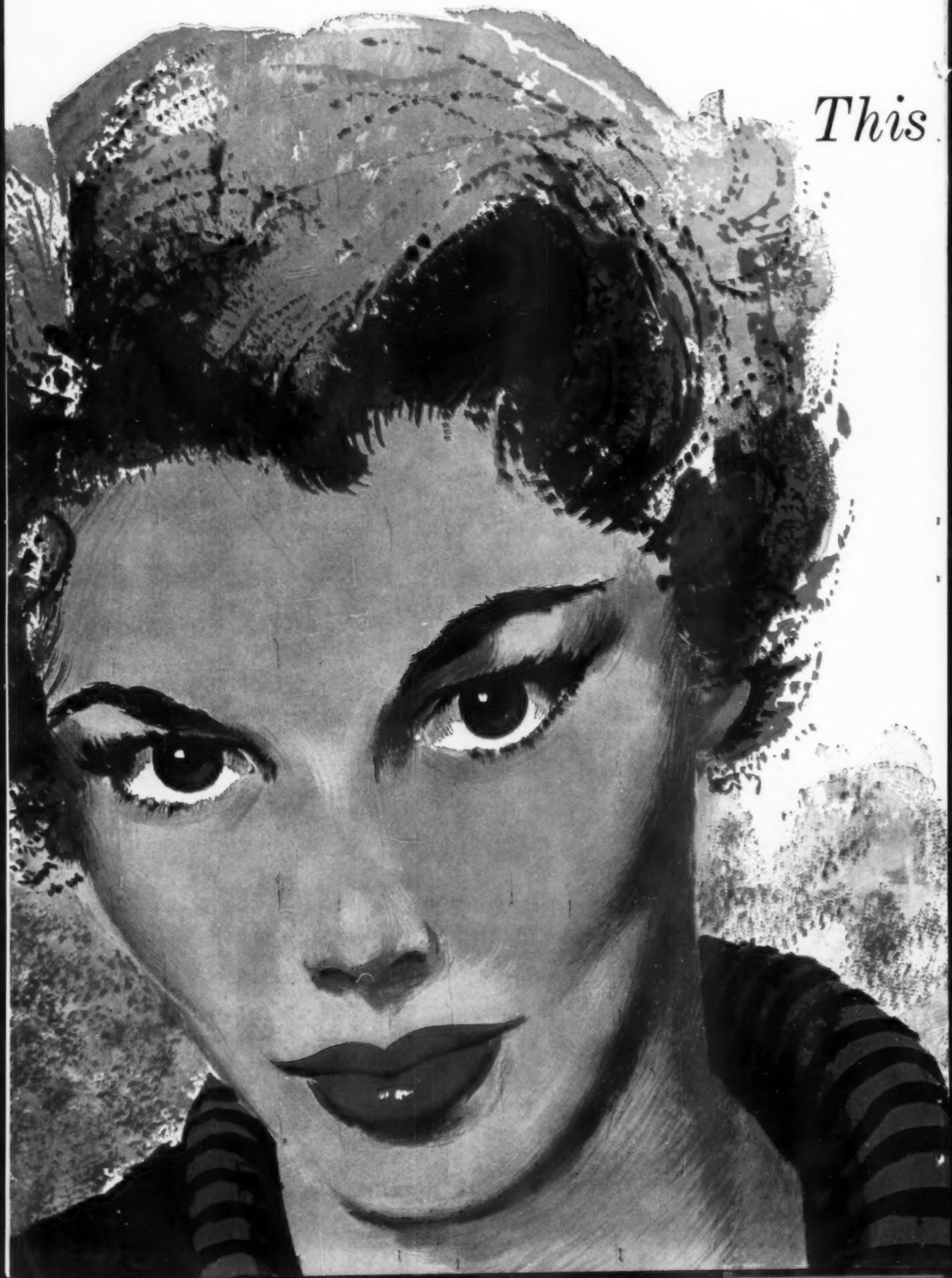
through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP


This

is the Mrs. behind the

MISSILE

ON THESE TWO PAGES YOU WILL READ HOW SHE HAS SOLVED ONE OF THE GREATEST PROBLEMS IN THE DEVELOPMENT OF GUIDED MISSILES TODAY

. . . and where

AC

fits in this picture

IT TAKES a special kind of woman to be the wife of one of today's missile men.

It takes a woman who can live within shouting distance of Death Valley . . . or the New Mexican desert around Holloman Air Force Base and White Sands. It takes a woman who can pack up the kids at a moment's notice for a few months' stay at Cape Canaveral, Florida . . . or Point Mugu, California.

You'll find these women everywhere in our Army, Navy and Air Force. You'll find them as the wives of scientists, or married to engineers for some of the largest industrial concerns in the nation.

They know more about the problems of raising a family virtually alone than they do about the business of producing the missiles themselves.

This advertisement is a tribute to the courage of such women, and to the very real contribution they are making to the development of a guided missile arsenal for this nation's defense.

Where AC fits in this picture

AC has been a leader in the development of an inertial guidance system for use in many types of guided missiles. This system, which we call the AChiever, is now in ballistic missiles and air-breathing missiles developed for use by our armed forces. It has made headlines and proved itself in flight in such missiles as the Air Force's Thor and Matador . . . and in the Navy's Regulus II.

The AChiever has far broader application than most systems developed for a similar purpose. It can, for example, guide a missile far beyond the confines of earth. It could put a satellite into orbit . . . or take a rocket to the moon . . . and it is not subject to interference by any known natural or man-made force. And, AChiever is in volume production.

These remarkable accomplishments have been made possible in large part by the faith and understanding of the wives of the men at AC and their counterparts in the armed forces, in science and industry.

—If you are such a woman, and your husband has engineering or scientific training which could make a contribution to this program, and is not a member of the armed forces, ask him to write—or write yourself—to the personnel section of AC in Milwaukee.

AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Can you automatically control speeds from 1/4 in./min. to 50 in./min. on your water-hydraulic press?

With Loewy's new automatic program speed control you can

One of the largest presses in existence, this closed die forging press designed and built by Loewy, and in operation at the Wyman Gordon plant, North Grafton, Mass., features automatic program speed control.

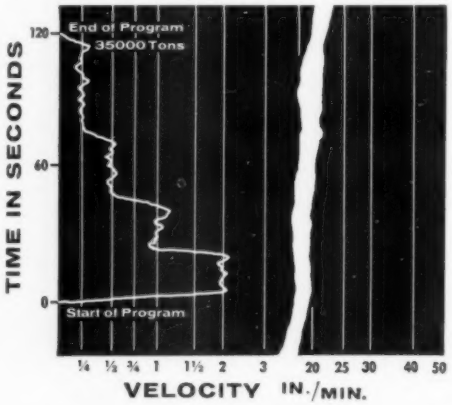
Structural and machine parts in aircraft, missiles and nuclear apparatus today demand greater strength and resistance to high temperatures, and many have extremely thin areas. Machining and other metal removing processes are not economical, due to the high cost of labor, waste of expensive alloy material, and loss of structural strength from cutting across the flow lines of metal. New metals, new methods and new equipment are needed for the economical production of parts that will consistently meet the severest requirements.

Regardless of which metal process is employed—extrusion, forging, die forging or deep drawing—the sound flow of material depends on so many variables that it becomes exceedingly difficult to coordinate them manually, especially in repeat performance. Excessively high speed may result in tears and uneven filling of die cavities. Unduly low speed may cause uneven cooling of material and, hence, interruption of the forming cycle.

To solve the problems of automatically controlling water-actuated hydraulic presses, Loewy-Hydropress had to bring to bear not only its resources in metallurgy and process engineering, but also its unique facilities in design of electronic controls.

The result is equipment which programs the change of speed and pressing force at preselected positions of the press stroke in existing installations. This makes it possible to translate experience in the production of high-quality metal parts into automatic repeat performance on any size hydraulic presses, including even the largest water-actuated presses, where such control was before unthinkable. Also it limits the maximum pressing force to a preset value and thus protects the tooling against overload.

For detailed information on the plastic forming of metals and on automatic controls for any machine process, write us today, Dept. H-5.



Graph shows a typical automatic control cycle consisting of four preselected speeds at preselected stroke positions up to 2 in./min. The workpiece is a 36-in. diameter steel billet. Pressure ranges from 6000 to 35,000 tons. Speeds range from ¼ in./min. to 2 in./min. and total pressing time is 2 minutes.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

BALDWIN BLH LIMA-HAMILTON

Friendly Foe

When a new air defense missile is produced, its "kill accuracy" is theoretical until it is tested against a realistic target under operational conditions. The new, supersonic missile target, **USAF XQ-4,** is one of many "friendly foes" developed by Radioplane to simulate various air enemy threats.

Duplicating the performance and radar appearance of a supersonic, high-altitude bomber, the radar-controlled XQ-4 is designed to test the seek-and-kill ability of air defense systems and their missiles.

As major advancements have been made in U.S. Armed Forces air defense weapon systems, Radioplane has designed and developed targets compatible with the missions of these weapons. The XQ-4, for example, not only imitates invading bombers, but tallies up the score of hits and misses when fired upon.

Radioplane, the first to produce remotely controlled target aircraft, maintains dynamic research programs to seek low-cost solutions for tomorrow's defense problems.

Radioplane

A Division of Northrop Aircraft, Inc.

VAN NUYS, CALIFORNIA, AND EL PASO, TEXAS

How to make a Pony do a Plow-horse Job

New Allison CT-3340 brings TORQMATIC muscle for the first time to 7-yd. scrapers and small materials handlers.

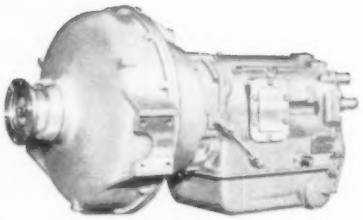
A scraper with TORQMATIC delivers more power at the blade – faster work cycles–more time on the job.

Any operator of a TORQMATIC-equipped giant scraper can vouch for that. Now, for the first time, the proved advantages of TORQMATIC are available in several small scrapers, haulers and other materials handlers with the new TORQMATIC CT-3340.

Take a tip from more than 80 manufacturers of 122 different types of construction and road-building equipment.

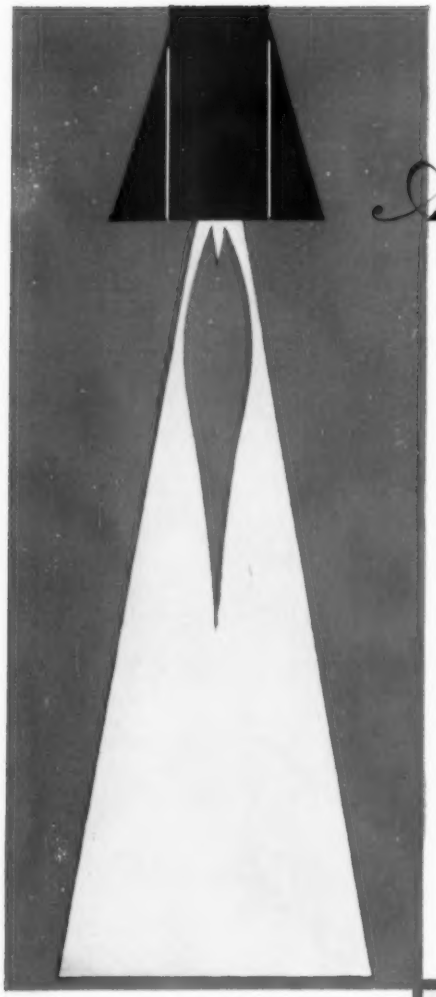
Get the Allison TORQMATIC story. Ask your equipment dealer, or write:

Allison Division of General Motors, Indianapolis 6, Indiana



- New "straight-through" design provides maximum capacity in minimum space.
- Full power shifts in all speeds: 4 forward, 2 reverse, including high-speed overdrive for return trips.
- Net torque input–350 ft -lbs.
- Multiplies engine torque 300%.
- Total torque ratio: 15.9:1.

Allison TORQMATIC® DRIVES



Announcing a specialized

MISSILE SUPPORT SERVICE

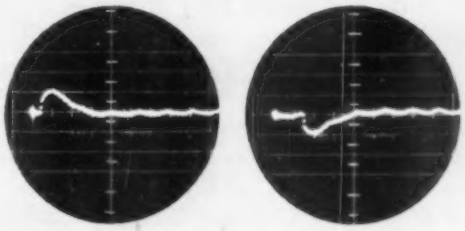
You worry about the missile... let Packard Bell Electronics take care of ground support! Proven performance in this field has resulted in a separate missile equipment section devoted exclusively to ground test and launching equipment. Here, in a 21,500 sq. ft. facility geared for short run production, experienced management shoulders complete responsibility. Here the most radical design changes are absorbed during the process of development. Here direct assembly supervision by production engineers eliminates costly and time-consuming delays. A reliable source, any way you look at it. And a reliable way to rid yourself of a major headache!

ENGINEERING BEYOND THE EXPECTED

DESIGN—When time dictates, available equipment can be adapted to your specifications. But you receive custom design, *beyond the expected*, when you need it. For example, the transistorized MAGAMP power supply (right). This unit provides a faster response time... a lower overshoot and undershoot... and remote regulation at longer distances than has ever been achieved before with this type of power supply.

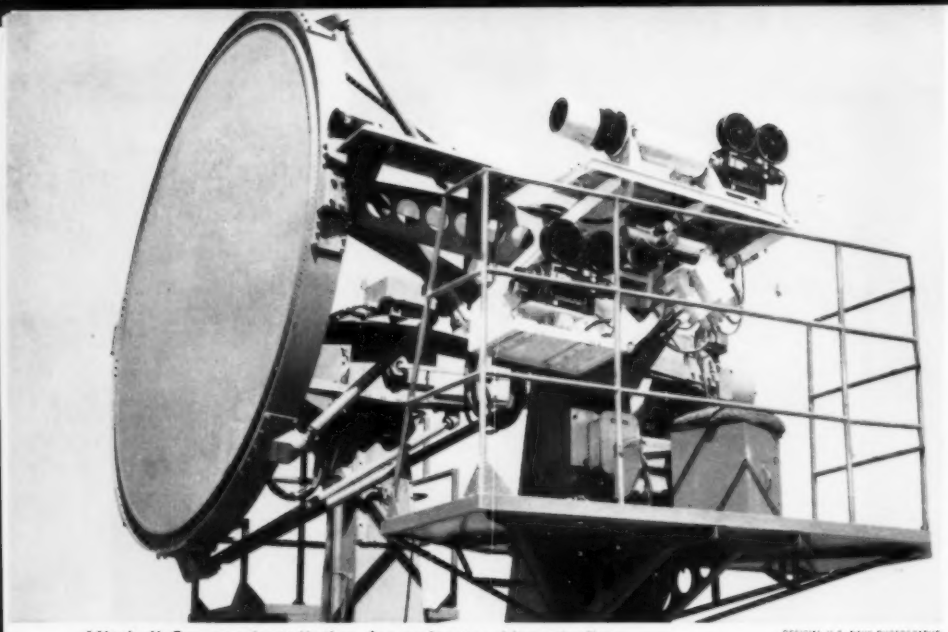
DELIVERY—A contract from Douglas Aircraft for "Thor" test equipment was awarded in March 1956. A total of 100 units, comprising 30 different units, was delivered before deadline in November. On-time delivery at its best... delivery *beyond the expected.*

This transistorized MAGAMP power supply delivers a 27V to 42V output at 0 to 300 amperes, *regulated at a load up to several hundred feet away.*



The MAGAMP has a surge capacity of 400% overload for 2 seconds. Regulation at the load is 1% or better. Recovery time is less than 50 milliseconds. Overshoot and undershoot are less than 25%, with a 30% change in load. (Scale in above photos: 5V/CM and 10MS/CM.)

PACKARD BELL ELECTRONICS
Missile Equipment Section
Technical Products Division
12333 W. Olympic Blvd.
Los Angeles 64, Calif. · BRadshaw 2-2171

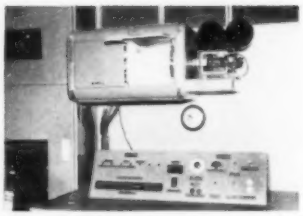


Mitchell Camera installation for radar tracking studies.

OFFICIAL U.S. NAVY PHOTOGRAPHS

HOW MITCHELL CAMERAS SUPPLY VARIED DATA IN ROCKETS AND MISSILES DEVELOPMENT

- Exact Pin Registration During Film Exposure
- Event Time to 1 Millisecond



Data dial instrumentation by Mitchell camera.

Extensive testing instruments incorporating Mitchell 16mm, 35mm and 70mm cameras provide key data at the U.S. Naval Ordnance Test Station at China Lake, Calif., one of the primary weapon development centers of the Navy's Bureau of Ordnance.

Fifty Mitchell 35mm cameras are used on radars, tracking camera mounts and fixed tripods to record missile and rocket development. Camera motors allow synchronous as well as in-phase operation of several cameras covering a test... important in film assessing. Eight 16mm Mitchell cameras are used for pictorial coverage of tests.

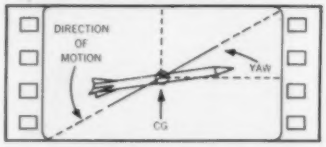
One metric photographic group shoots as much as 20,000 feet of 35mm film in one day. Other Mitchell cameras record underwater, engineering and aviation tests at this ordnance center.

For information on Mitchell cameras, write describing your requirements.

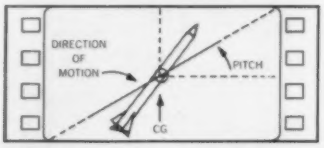
Mitchell Camera
CORPORATION
666 WEST HARVARD STREET
GLENDALE 4, CALIFORNIA
Cable Address: "MITCAMCO"

85% Of Professional Motion Pictures Shown Throughout The World Are Filmed With Mitchell Cameras

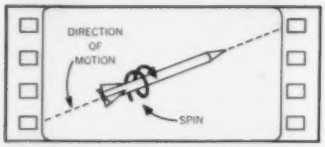
The Mitchell camera, by virtue of its exact pin registration during film exposure, allows these data to be determined to a reasonably high degree of accuracy through the use of film assessing equipment built to take advantage of this feature:



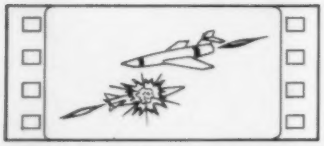
Yaw—Side-to-side motion of missile.



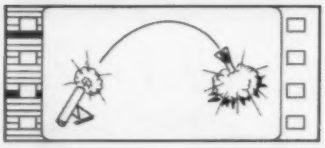
Pitch—Up-and-down motion of missile.



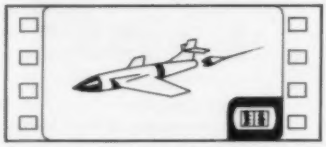
Roll—Turning motion of missile.



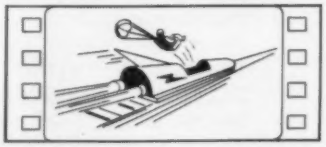
Miss Distance—Gap between missile and target at point of interception.



Flight Time—A series of lines on film; timed to accuracy of 1 millisecond.



Position Data—Target location with azimuth and elevation readings.



Pictorial Record—Record of all visible actions during test.

Separation Data—High-speed separation actions for detailed study.

ASTROLITE . . . a remarkable new high temperature material for Rocket and Missile insulation applications!

Out of HITCO's high temperature laboratories comes ASTROLITE . . . a **Refrasil-reinforced plastic** with impressive resistance to extremely high temperatures.

The excellent thermal shock characteristics and other outstanding physical properties of ASTROLITE make it an ideal insulation material to aid in Man's successful exploration of Space.

ASTROLITE is already proposed for use as liners for rocket engines and nozzles, nose cones for Intercontinental Ballistic Missiles and heat shields to protect critical components.

Complete technical data and dramatic proof of ASTROLITE's remarkable resistance to extremely high temperatures to 5000°F. **and higher** . . . is yours for the asking. Write to Director of Research.

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Phone REpublic 3-9161

FREE NEW CHART!
Covers important points to consider in selecting high temperature insulation

WRITE OR CALL YOUR NEAREST HITCO REPRESENTATIVE: EASTERN: Tom Kimberly, 38 Crescent Circle, Cheshire, Conn., BRowning 2-6544 • Fred W. Muhlenfeld, 4011 Loch Hill Road, Baltimore 12, Md., VAlley 5-3135 • **MIDWEST:** Burnie L. Weddle, 1347 Pennsylvania St., Indianapolis 2, Ind. MElrose 5-5607 • **SOUTHWEST:** Marshall Morris, 2850A West Berry, Rm. 14, Fort Worth, Texas, WAlnut 4-8679 • **NORTHWEST:** J. L. Larsen, 5757 Oaklawn Place, Seattle, Wash., MOnark 9311

CANADIAN PLANT: THE H. I. THOMPSON CO. OF CANADA LTD., 60 Johnston Street, Guelph, Ontario, Telephone: TAylor 2-6630

ND FACTS

BRIGHT PATH OF PRECISION!

Every stage of a missile's flight from take-off to target is marked by the necessity for a degree of accuracy in its controlling parts far greater than required in any previous instrumentation.

That bright path of success written in the skies by missiles of various kinds is visible evidence of the extreme precision built into the New Departure ball bearings used in the gyroscopes, servos and other vital elements of the guidance systems.

New Departure takes great pride in its ability to meet the exacting specifications of the products for the Army, Navy and Air Force programs.

Comparator measures dimensions to one-millionth of an inch. One of many pieces of ultra-precision equipment in the New Departure bearing laboratories.

In many bearings, various dimensions and surface finishes must be held to within tolerances of a few millionths of an inch.

1908–1958

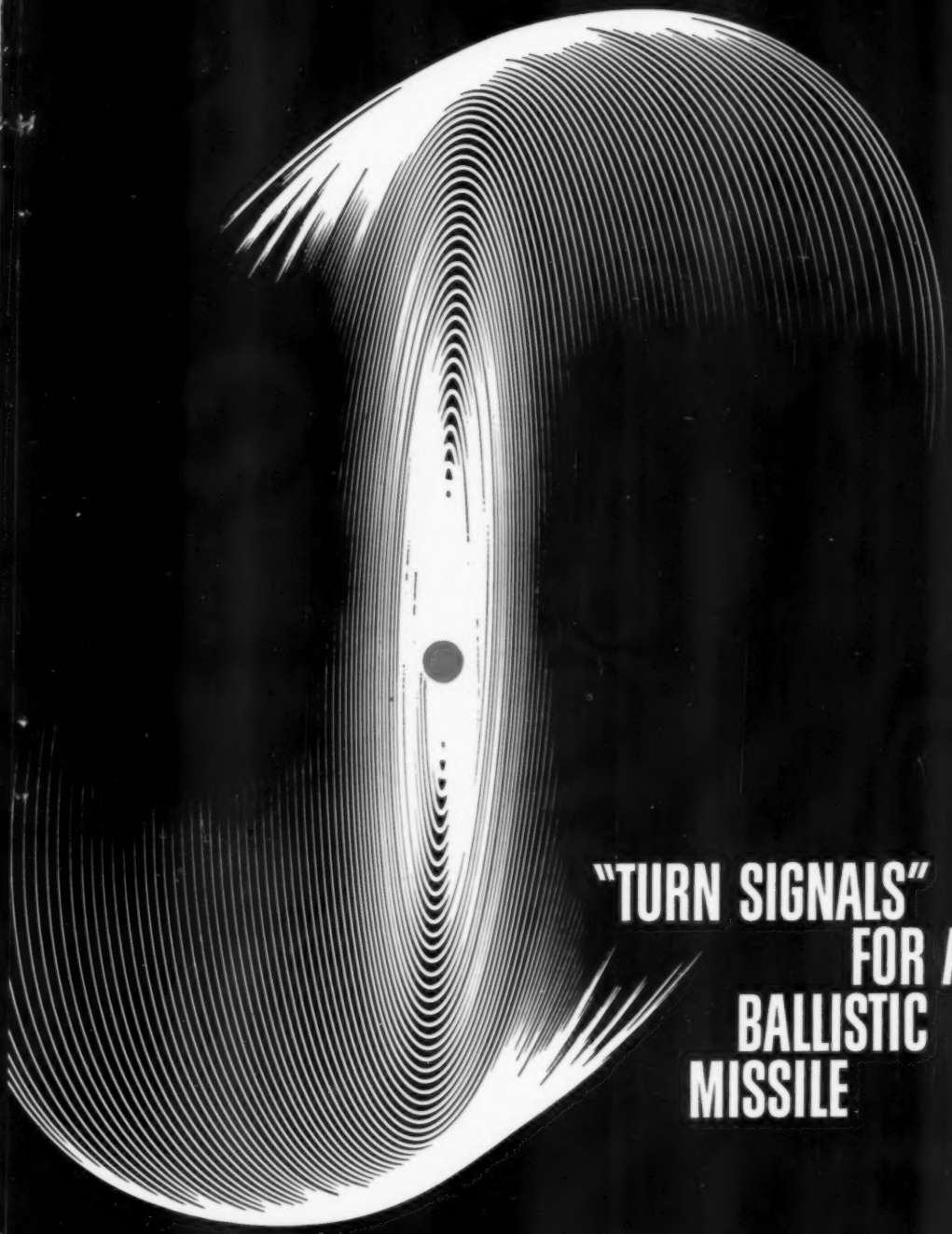
GM

FORWARD FROM FIFTY

ND NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL



"TURN SIGNALS" FOR A BALLISTIC MISSILE

BURROUGHS ELECTRONIC COMPUTER "MASTERMINDS" THE ATLAS INTERCONTINENTAL BALLISTIC MISSILE

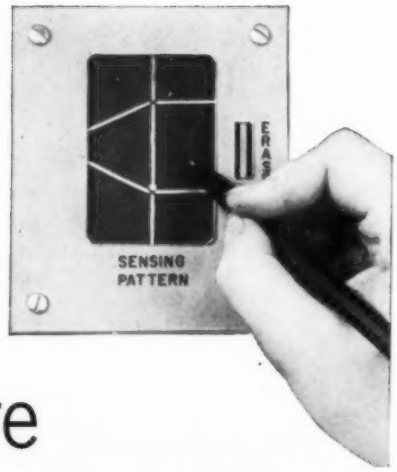
Steering the 250-mile-per-minute Atlas into the precise trajectory required for the missile to accurately strike its target 5,500 miles away, calls for incredibly close computation. And that's where Burroughs comes in—with an electronic computer specially designed to receive complex information, compare it with the pre-calculated direction, and signal the missile necessary changes to set it unerringly on its course.

Important contracts are not new to Burroughs Corporation with its 70 years of demonstrated competence. But it is the recent defense projects that serve best to underscore Burroughs' breadth and complete capability, from research through mass production to actual field installation and service. Burroughs Corporation, 6071 Second Avenue, Detroit 32, Michigan.

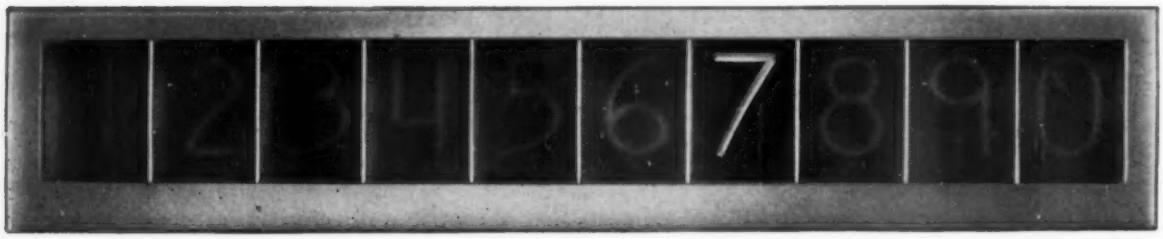
BURROUGHS CORPORATION

THE FOREMOST NAME IN COMPUTATION

Write a numeral here



and read it here



on new Bell Labs machine

A new device invented at Bell Laboratories "reads" a numeral while it is being written and instantly converts it into distinctive electric signals. The signals may be employed to make a numeral light up in a display panel, as above, or they may be sent to a computer or to a magnetic "memory" for storage.

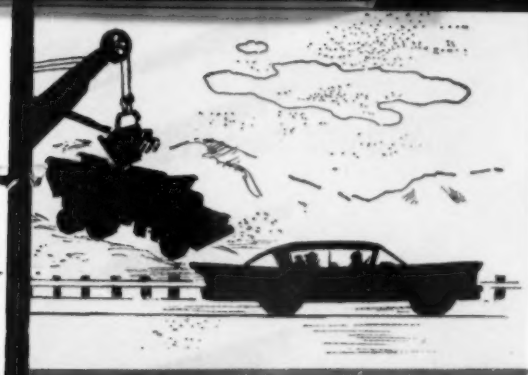
The writing is done with a metal stylus on a specially prepared surface. Two dots, one above the other, are used as reference points. Seven sensitized lines extend radially from the dots. Transistorized logic circuits recognize numerals according to which lines are crossed.

The concept of a number-reader has interesting possibilities as a new means of communication from humans to machines. For example, in an adjunct to a telephone, it might provide inexpensive means of converting handwritten data into signals which machines can read. The signals could be transmitted through the regular telephone network to a teletypewriter or computer at a distant point. In this way, a salesman might quickly and easily furnish sales data to headquarters, or a merchant might order goods from a warehouse.

Tom Dimond, a B.S. in E.E. from the University of Iowa, demonstrates an experimental model of his number-reading invention. A similar device can also be made to read alphabetical characters. Small size and low power requirements result from transistor circuitry.

Modern communication involves many more fields of inquiry than the transmission and reception of sound. The experimental number-reader is but one example of Bell Telephone Laboratories work to improve communications service.

BELL TELEPHONE LABORATORIES
World Center of Communications Research and Development



on land...

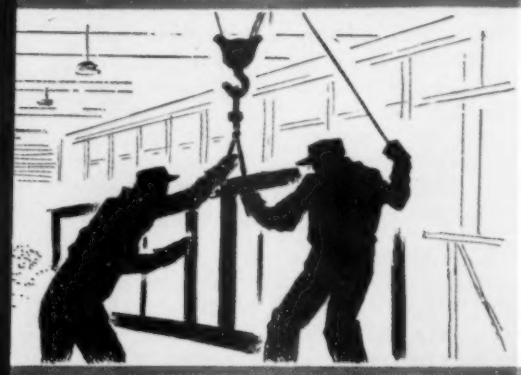
Parish produces auto and truck frames, machined and fabricated parts, field ranges, land mines, railroad hoods and railroad equipment, farm equipment, stampings and weldments.

in the air...

Parish turns out missile engines, JATO bottles, pylon tanks, cowling and practice bombs.

at sea...

Parish manufactures a stainless steel rudder, buoys, a guide used for mine sweeping and trailers used for sea hauling.



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Parish facilities cover the full range of metalworking, machining, welding, forming, heat-treating. They're available for additional work right now for defense . . . or other sub-contract work. Call or write for additional information . . . today!

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P **PARISH** PRESSED STEEL

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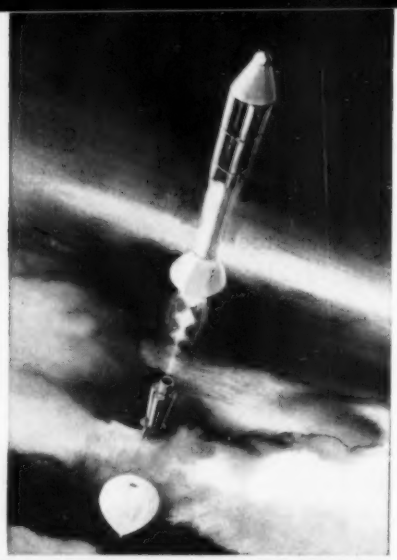


The artist's drawing shows Aeronutronic Systems' four-stage rocket leaving its launching station, a General Mills balloon. With much of the atmospheric drag behind it, the rocket can soar to far greater heights than those launched from usual earth stations.

We build rocket stations in the sky to speed man's conquest of space

This Project Farside polyethylene balloon is identical to the one used in the actual rocket flights. Here it is being readied for a test ascent. Its load is an exact replica (size and weight) of the platform and rockets which were carried to 100,000 feet at Eniwetok Atoll.

In Project Farside, General Mills' polyethylene balloons like this, the largest ever flown, lifted a series of rockets 100,000 feet above the earth. (The nearly 4,000-pound loads were the greatest ever carried to that height.) With 98.7 percent of the drag-producing atmosphere already behind them, the rockets could then be sent farther out into the unknown to gather scientific data essential to man's mastery of space.

Unusual projects of this type are a specialty of the complete balloon systems group at General Mills. The complete package includes balloon and instrument design and manufacture, launching and recovery services, weather forecasting and data reduction.

Such activity is representative of our capabilities and thoroughness in other fields: inertial guidance and control, infrared, radar, semiconductor physics, and so on. We combine creative engineering and research with fine-precision production to serve an increasing number of industrial and military customers. We'd like to serve you, too.

GET MORE FACTS about our facilities and capabilities and how they can serve you. Write Dept. OR-5, Mechanical Division, General Mills, 1620 Central Ave. N.E., Minneapolis 13, Minnesota.

MECHANICAL DIVISION

General Mills

Creative Research and Development + Precision Engineering and Production

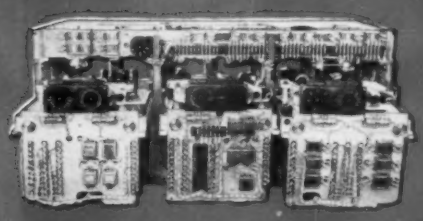
Minneapolis, Minnesota

A bird in hand...

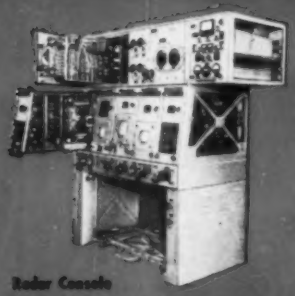
RADAR INTELLIGENCE FOR ALL APPLICATIONS

Produced at

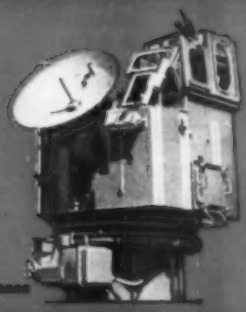
DAYSTROM INSTRUMENT



Fire Control Computer



Radar Console



Radar Antenna

Daystrom Instrument meets today's rigid requirements for Missile Control Equipment.

Our engineers and production specialists are qualified, ready and anxious to assist in your programs. Our new 350,000 sq. ft. plant is completely equipped with the most modern manufacturing and test facilities for the production of electronic and electro-mechanical products.

Be among our satisfied customers in the Armed Services and Industry. Contact us for complete information on how we can help you.

Remember—Reliability Is A Must At Daystrom Instrument.

DAYSTROM INSTRUMENT

Division of Daystrom, Inc.

ARCHBALD, PENNA.

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Admiral® makes harmless radio waves behave like deadly radiation

Radiac simulator safely trains personnel in detecting atomic radiation

The quivering needle creeps up the scale, warning that nuclear radiation of dangerous intensity is present. So it appears to the trainee learning to explore for radiation fields with the aid of Admiral's radiac simulator. Actually, his instrument has been energized by harmless radio signals from a nearby special transmitter. In this way he learns his hazardous trade without harmful personal exposure.

The instrument he will carry in actual field work looks and behaves, in the presence of nuclear radiation, exactly as his radiac simulator did. This is Admiral's achievement...designing a simulator that essentially duplicates with radio signals the performance of an ionization chamber instrument. It was accomplished by designing the special transmitter and a receiving circuit with miniaturized omni-directional antenna to operate effectively in an instrument of limited size. With it the trainee may turn in any direction, yet obtain a true reading. This development is the unique product of Admiral's associated experience in both nuclear radiation and radio communications. Exceptional facilities are available for research, development and production in the fields of military electronics and nuclear radiation. Address inquiries to:

Admiral® CORPORATION
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ENGINEERS. The wide scope of work in progress at Admiral creates challenging opportunities in the field of your choice. Write Director of Engineering and Research, Admiral Corporation, Chicago 47, Illinois.

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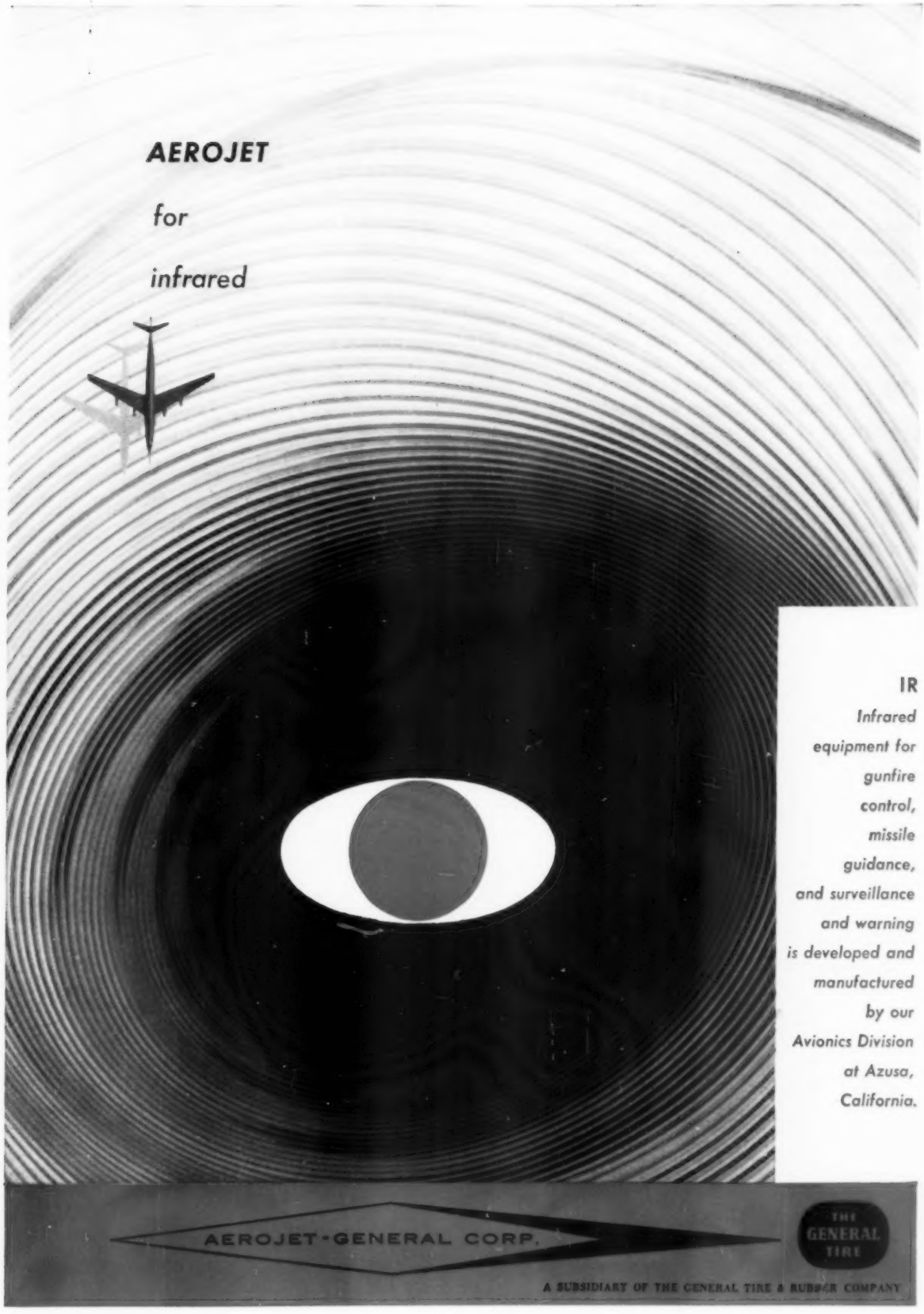
- DISTANCE MEASURING
- RADAR BEACONS AND IFF
- CODERS AND DECODERS
- MISSILE GUIDANCE
- CONSTANT DELAY LINES
- TEST EQUIPMENT

The activities referred to in this advertisement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Infrared equipment for gunfire control, missile guidance, and surveillance and warning is developed and manufactured by our Avionics Division at Azusa, California.
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THE GENERAL TIRE
A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Vought Vocabulary

e · con′ o · my: *when round-trip missiles save taxpayers $102,950,000*

Most missiles land head-first – and, like a bomb, just once. This destruction is desired in a missile strike, but it makes development costly. Scores of missiles often are expended before development problems are solved.

Vought's *Regulus I* and *II* reduce this expense by their dual application. Tactical versions of these guided missiles can strike head-on, with a devastating nuclear wallop. Test and training versions, used in development, can be recovered to fly again.

One *Regulus* was flown and recovered *18 times*... another made 16 successful flights. Six hundred recoveries of both missiles have saved $102,950,000 and gained an inestimable quantity of technical data.

Regulus I has armed submarines, cruisers and carriers with a nuclear punch since 1955. *Regulus II*, with a range of more than 1,000 miles and able to exceed twice the speed of sound, soon will join the Navy's underwater and surface Nuclear Fleet.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

Platers find many uses for chelating *cleaner

*Chelating (pronounced key-lating) cleaners convert metallic salts and oxides into compounds soluble in water.

By chelating and removing rust or heat scale at the same time that it removes oil, Oakite Rustripper combines pickling and alkaline cleaning into one operation. It also avoids disadvantages of acid pickling, such as hydrogen embrittlement and etching of machined surfaces.

Platers now use Rustripper for dozens of difficult steel-cleaning jobs. Here are some examples reported in recent weeks:

CALIFORNIA: "Rustripper has ended pickling damage such as embrittlement." (Removing oil and light rust from machined landing gears before cadmium plating.)

NEW YORK: "Now saving about $10.40 per day on removing rust and scale and producing brighter plate." (Rustripper, added to reverse current cleaner in automatic plating machine, has eliminated separate pickling of wire towel racks before nickel and chrome plating.)

CONNECTICUT: "Rustripper added to reverse current cleaner has eliminated troublesome smut from metal furniture prior to copper-nickel-chrome plating."

NEW YORK: "Rustripper very good in barrels for derusting and brightening business machine parts . . . also for removing brown stains from parts put through black oxide treatment."

NEW YORK: "Small steel aircraft parts were embrittled by acid pickling. Rust, heat scale and stains are now safely removed by Rustripper and cyanide."

NEW JERSEY: "Only two cleaning rejects in first 15,000 parts plated." (After Rustripper was added to reverse current cleaner in automatic plater to eliminate smut from tubular steel furniture.)

INDIANA: "Rustripper is the best barrel compound we ever used for this job." (Removing tough heat treat scale from steel screws.) "Total cleaning and zinc plating time has been cut in half."

NEW YORK: "Had trouble with light rust on business machine parts before cadmium plating; also with smut left after electrocleaning. Rustripper cured both troubles."

FREE A 14-page illustrated booklet called *"Here's the best shortcut in the field of electroplating"* tells about many ways in which Oakite Rustripper can be of great value in the plating shop. Write to Oakite Products, Inc., 40 Rector St., New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
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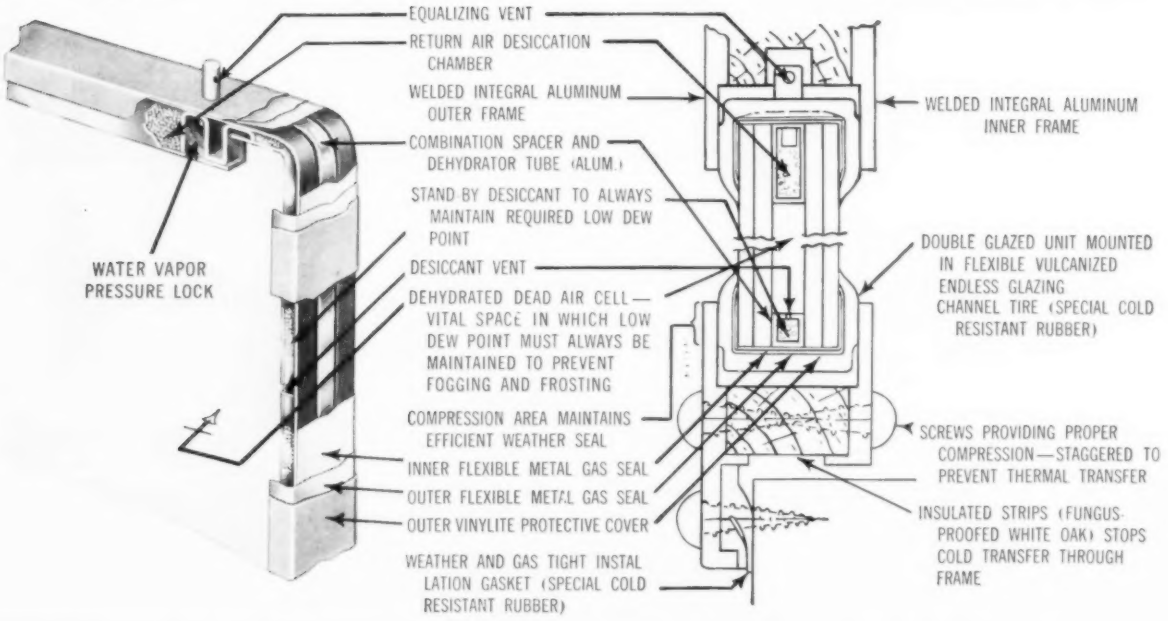
under any conditions!

HIGH EDWARDS ALTITUDE WINDOW ASSEMBLIES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RETURN AIR DESICCATION CHAMBER
WELDED INTEGRAL ALUMINUM OUTER FRAME
COMBINATION SPACER AND DEHYDRATOR TUBE (ALUM.)
STAND BY DESICCANT TO ALWAYS MAINTAIN REQUIRED LOW DEW POINT
WATER VAPOR PRESSURE LOCK
DESICCANT VENT
DEHYDRATED DEAD AIR CELL—VITAL SPACE IN WHICH LOW DEW POINT MUST ALWAYS BE MAINTAINED TO PREVENT FOGGING AND FROSTING
COMPRESSION AREA MAINTAINS EFFICIENT WEATHER SEAL
INNER FLEXIBLE METAL GAS SEAL
OUTER FLEXIBLE METAL GAS SEAL
OUTER VINYLITE PROTECTIVE COVER
WEATHER AND GAS TIGHT INSTAL LATION GASKET (SPECIAL COLD RESISTANT RUBBER)
WELDED INTEGRAL ALUMINUM INNER FRAME
DOUBLE GLAZED UNIT MOUNTED IN FLEXIBLE VULCANIZED ENDLESS GLAZING CHANNEL TIRE (SPECIAL COLD RESISTANT RUBBER)
SCREWS PROVIDING PROPER COMPRESSION—STAGGERED TO PREVENT THERMAL TRANSFER
INSULATED STRIPS (FUNGUS-PROOFED WHITE OAK) STOPS COLD TRANSFER THROUGH FRAME

Only EDWARDS units GUARANTEE brilliant

SEE THESE TESTS

AT OUR FACTORY OR, UPON REQUEST, ANYWHERE YOU PLEASE!

HIGH ALTITUDE TEST

Top window in vacuum chamber, *without* pressure release system, shattered at the equivalent of 9,000 feet elevation.

Lower window in vacuum chamber demonstrates the efficiency of the Edwards pressure relief system, permitting the Edwards High Altitude Window to be taken to any altitude and returned to sea level at an ascent or descent rate up to 3,000 f.p.m. without impairment of seal, bursting of glass or lowering of dew point in dead air space.

as proved by

Advanced engineering exceeds exacting requirements for Air-borne units!

THE PROBLEM: A Double Glazed High Altitude Window for the armed forces which could be repeatedly air-borne to any altitude without bursting or loss of efficiency, yet always providing constantly clear vision at temperature ranges from +140° to −65° F., while affording maximum insulation against heat or cold transfer.

THE SOLUTION: Achieved seven years ago with the development of Edwards High Altitude Window Assemblies, a result of our years of experience in producing non-fogging, non-frosting double glazed units for the transportation system of America. Today, 100,000 of these High Altitude Windows, in a wide range of design, are meeting every requirement of the armed forces.

EXCLUSIVE FEATURES: The drawing at the left indicates the many advanced features which are found in no other window assemblies of this type, including:

Positive, flexible metal seal of the dead air space (between the two glass panels) which is not only air tight but, much more important, is practically water vapor tight.

Since no known seal can entirely stop the infiltration of water vapor, an ample supply of dessicant insures long unit life and always maintains the required low dewpoint of −30° to −40° F.

Pressure relief system (for air-borne requirements) vents the dead air space during the ascent of the unit and recharges the dead air space during descent without alteration of the original low dewpoint.

FOR COMPLETE, DETAILED INFORMATION, WRITE:

THE O. M. EDWARDS COMPANY, INC.

SYRACUSE, NEW YORK

NEW YORK OFFICE: 50 CHURCH STREET, NEW YORK 7, N. Y.

EDWARDS . . . *the Eyes of Transportation*

TYPICAL SERVICE APPLICATIONS

AIR FORCE CRASH TRUCK

Edwards regulator drop-type windshield with heat resistant glass and *high-altitude* window assemblies.

MACHINE SHOP VAN

Edwards *high-altitude*, top-hinged, push-out window assemblies with insect screens and blackout blinds.

ARCTIC SNOW PLOW CARRIER

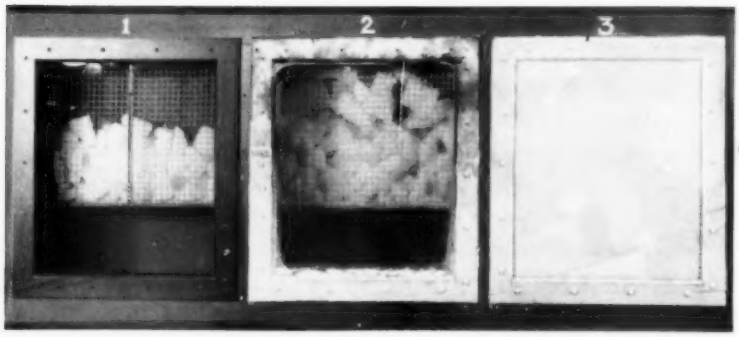
Edwards *high-altitude*, heavy-duty windshield (83 x 32) and drop-down window assemblies with regulators.

RADAR-ELECTRONIC SHELTER

Edwards top-hinged, push-out, *high-altitude* windows with inside insect screens and outside blackout blinds.

vision at temperatures from +140° to −65° F.

100,000 assemblies now in Military Service



ARCTIC COLD TEST

Here is demonstrated the ability of the Edwards High Altitude Window to insulate against the transfer of heat and cold and provide clear visibility and maximum light transfer at temperatures of −65° F. and lower. Photos left to right: (Fig. 1) Edwards High-Altitude Window. (Fig. 2) Standard double-glazed, non-insulated window. (Fig. 3) Single-glazed, non-insulated window. Results of these tests demonstrate and explain why the Edwards High Altitude Double-Glazed Window is specified by the armed services in all types of mobile air-borne equipment.

now available
MAMMOTH EXTRUSIONS

Big magnesium and aluminum extrusions produced from Dow's 13,200 ton press

A whole new range of king-size dimensions is now available for design engineers. Dow's new 13,200 ton extrusion press at Madison, Illinois, is producing "special" sizes for quick delivery. These projects include work for aircraft and missiles, automotive, building, and highway construction.

Here's what the big press can do in the way of magnesium and aluminum extrusions to meet your special requirements.

Check this list:

1. **LARGER EXTRUSIONS. Sizes up to a circumscribing circle of 30"**
2. **LONGER EXTRUSIONS. Up to 80 feet in length**
3. **THINNER SECTIONS. Down to 0.125"**
4. **STEPPED EXTRUSIONS. Solid or hollow**
5. **COMBINED HOLLOW EXTRUSION-FORGINGS**

***FOR DESCRIPTIVE LITERATURE** on the big press, contact your nearest Dow sales office, or write The Dow Chemical Company, Midland, Michigan, Dept.* MA-1401R—F

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Out of advanced research, development and production at Hoffman

GYROS

FOR INERTIAL NAVIGATION AND GUIDANCE SYSTEMS

Designed and Developed by Humphrey, Inc., San Diego, Calif.

Electro-Mechanical Equipment—such as the Air Force's ASN-6 Automatic Dead Reckoning Navigation Computer now in production at Hoffman—include gyroscopes, inertial navigation systems and components, servomechanisms, fire control systems, and guided missile controls. These are examples of the special Hoffman skills and electro-mechanical capabilities which can help solve your design problems.

Hoffman Electronics CORPORATION

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STARTING UNIT
for
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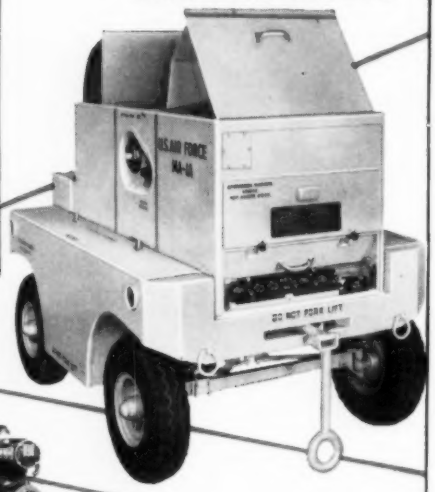
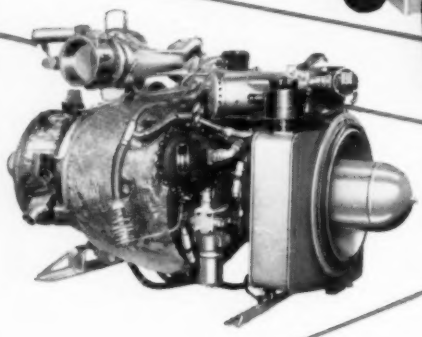
AIRCRAFT





MODEL 141
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ENGINE

Typical of the fine results of Continental development is the TC-106 portable starting unit for large jet aircraft. This advanced new model, with a high performance turbine compressor as its heart, weighs one-third less than its predecessor, yet has 17 per cent higher output, and in addition, other important qualities: greater mobility, less noise, and a completely automatic control system. . . . It is now in volume production at the Continental Aviation and Engineering Toledo plant

•

C.A.E. gas turbine models—the J69-T-9, the J69-T-2, and the J69-T-19A are being built for Cessna's T-37A twin jet trainer, Temco's TT-1 Navy jet trainer, the Beech jet Mentor trainer, and the Ryan Q-2A Fire Bee target drone.

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ATOMIC ENERGY

EXPLOSIVE HAZARDS

A recent statement issued jointly by the Department of Defense and the Atomic Energy Commission declared that the possibility of an accidental nuclear explosion while transporting or storing nuclear weapons is so remote as to be negligible.

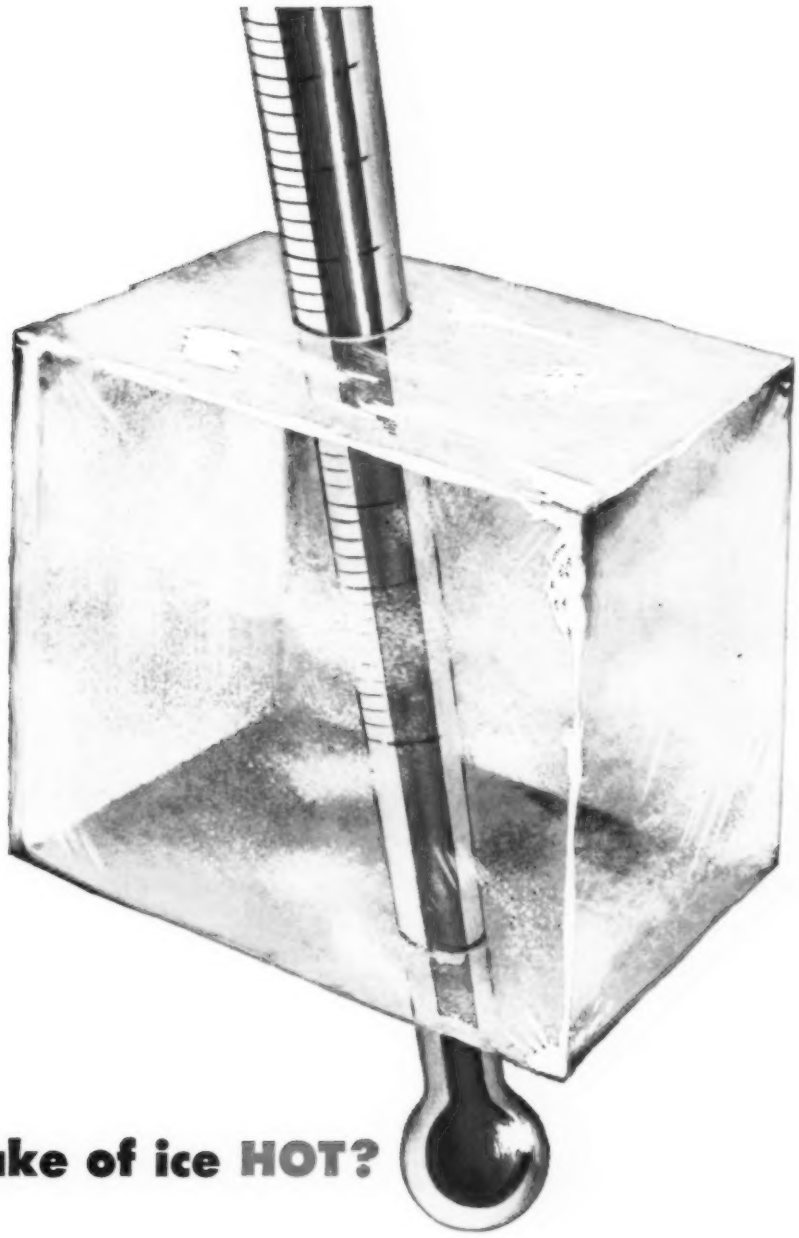
For the past twelve years nuclear weapons have been moved from places of manufacture in the United States to places of storage and readiness for use. They have been moved by many types of conveyance. In addition, they have been carried on aircraft, ships, and trucks in maneuvers, exercises, and practice alerts.

Although, as in the case of any toxic, inflammable, or explosive material, accidents may occur in the manufacture, transportation, and storage of nuclear materials and weapons, there have been few accidents in the handling and transportation of the latter. It is significant that not one of these accidents caused a nuclear explosion.

By a nuclear explosion is meant a fission or fusion reaction creating a large explosive effect. Many nuclear weapons, however, contain some amount of conventional explosives, that is, chemical explosives similar to TNT. An accident such as the crash of an aircraft or severe wreck of a train carrying a nuclear weapon may cause this conventional explosive to detonate by impact or fire.

An accidental detonation of conventional explosives might possibly cause local scattering of nuclear materials in the form of dust. This would not be a fallout of fissioned materials, but unfissioned nuclear material could be spread locally by wind or explosion. Such materials could be hazardous only if taken internally, as by breathing. Even then, under strict safety measures adopted by Defense and AEC restricting the quantities that may be carried, it is unlikely any person inadvertently exposed would inhale dangerous amounts of the unfissioned materials.

To minimize all unnecessary exposure, key U. S. military commands and AEC establishments have teams especially trained and equipped to decontaminate the area at the immediate site of the accident if the nuclear materials have been scattered by fire or conventional explosion. Such teams are prepared to go immediately to the scene. Past experience



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has shown that clean-up procedures are highly effective.

NUCLEAR TANKER STUDIED

The Atomic Energy Commission and the Maritime Administration recently announced the award of contracts for preliminary engineering and design studies for the conversion to nuclear power of a tanker now under construction. The contracts are with George G. Sharp, Inc., as the ship design agent and the General Electric Company, as the reactor designer. The companies will work concurrently and together to provide the necessary contract plans and specifications for a reactor and for conversion of the ship.

The studies will outline the engineering problems and will provide a basis for cost estimates for the conversion of the ship to nuclear propulsion.

The tanker, under construction at the Ingalls Shipbuilding Corporation in Pascagoula, Miss., is a 22,500-deadweight-ton prototype, designed for a normal speed of 20 knots at 20,000 shaft horsepower.

URANIUM PRODUCTION

The AEC recently announced the annual statistics on domestic uranium production for 1957. Included were figures on uranium concentrate, rate of ore processing, domestic ore production, ore fed to process, ore stockpiling, and initial production bonus payments.

Domestic ore reserves were estimated to total 78,000,000 tons on December 31, 1957. This compares with 60,000,000 tons estimated at the end of 1956. Ore receipts at all private plants and Government purchase depots in 1957 totaled 3,676,000 dry short tons; ore fed to process totaled 3,575,000 tons with an average 0.27 per cent of U_3O_8; ore stockpiled as of December 31st was 2,033,000 dry tons; and $2,447,835 was paid during the year in initial production bonus payments.

At the end of 1957 there were sixteen uranium-processing mills in operation, including the Government-owned mill at Monticello, Utah. Several new plants are scheduled to be completed in early 1958.

At year's end domestic uranium concentrate production had reached an annual rate of 10,000 tons of uranium oxide (U_3O_8). Concentrates produced in the United States and received by the Commission during calendar year 1957 totaled 8,640 tons of U_3O_8.

Included in this total are 146 tons which were produced as a by-product in the chemical processing of phosphate rock in Florida and Illinois; from the treatment of Idaho euxenite at the St. Louis plant of Mallinckrodt Chemical Company; and from reprocessing of refinery residues at Vitro Corporation's Canonsburg, Pa., plant.

Receipts by AEC from foreign sources were 11,826 tons of U_3O_8 (December estimated) making a total for both domestic and foreign of 20,466 tons.

At the beginning of 1957, there were twelve operating mills in the western United States. Four additional mills came into production during the year.

SERVICE DISCONTINUED

The Atomic Energy Commission is no longer accepting new requests for gamma irradiation service from the public when the requested service is readily available commercially. A recent Commission survey showed that at least sixteen academic and industrial organizations are prepared to provide gamma irradiation service on a commercial basis. This number is believed to be large enough to assure service at reasonable prices.

The Commission has decided, therefore, to discontinue the service, in line with its general policy of furnishing materials and services only when they are not reasonably available commercially. The Commission will continue to provide irradiation service to Federal agencies.

ITALIAN REACTOR

The U. S. Government will contribute $350,000 toward the cost of a nuclear research reactor project being undertaken by the Italian National Committee for Nuclear Research (CNRN).

The reactor, a heavy-water-cooled and moderated 5 MW heterogeneous research type, will be the principal technical facility at a new nuclear research center located at Ispra in northern Italy. The U. S. will lease uranium fuel enriched to twenty per cent under terms of the research agreement for coöperation in effect with Italy.

The Italian project is the eighth to receive U. S. financial support under procedures developed to carry out the offer of President Eisenhower in June 1955 to assist other nations on nuclear research reactor programs as a part of the Atoms for Peace Program. The funds have been made available to the Commission by the U. S. International Coöperation Administration out of Mutual Security Funds and will be transferred to the Government of Italy upon completion of the project.

ATOMS FOR PEACE

The AEC and the Government of Italy on February 13, 1958, signed a contract for the sale of approximately 2,000 kilograms of normal uranium. Under the terms of the contract the Commission will sell the normal uranium to Italy in the form of aluminum-clad rods which will be used in the construction of a subcritical assembly located at the University of Cagliari on the island of Sardinia.

On February 14, 1958, representatives of the Commission and the Government of Australia signed a contract for the sale of 2,000 pounds of heavy water for use in a materials-testing and research reactor and in support of reactor physics experimental work.

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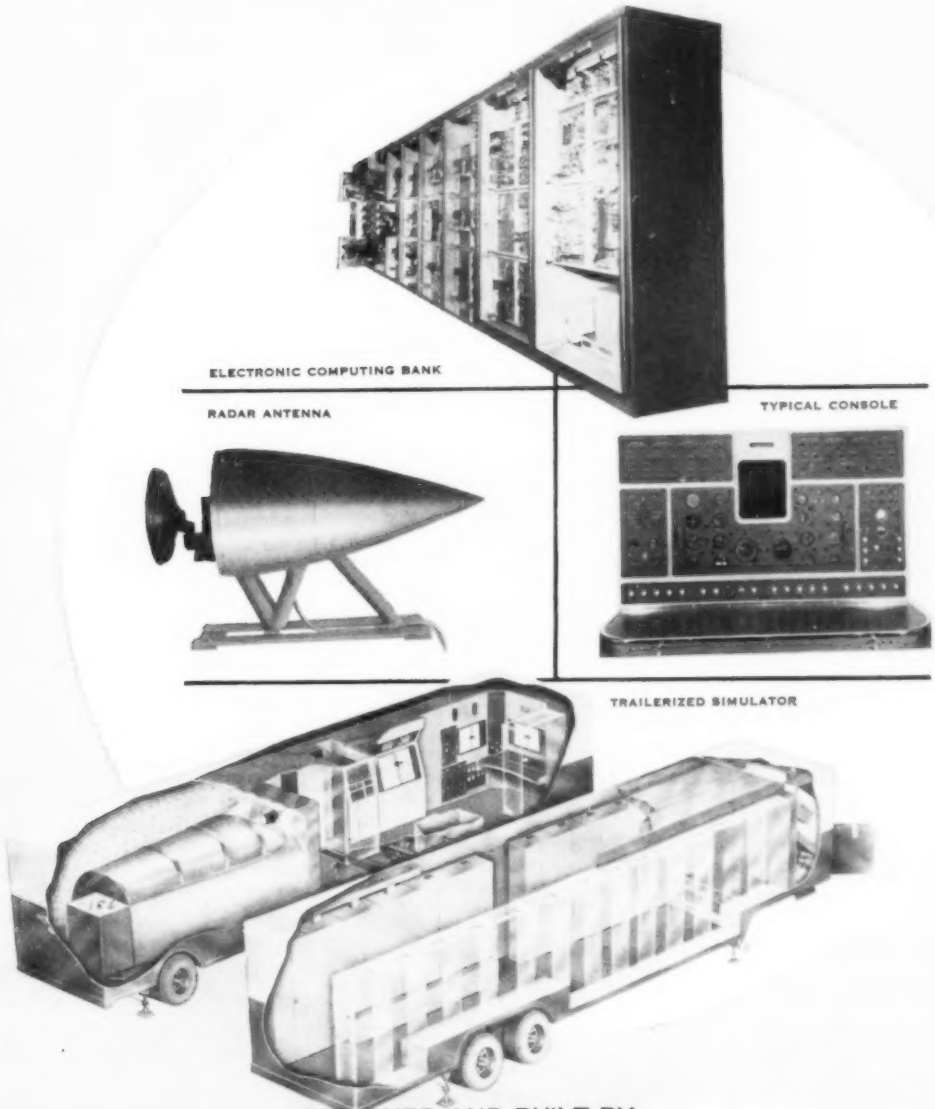

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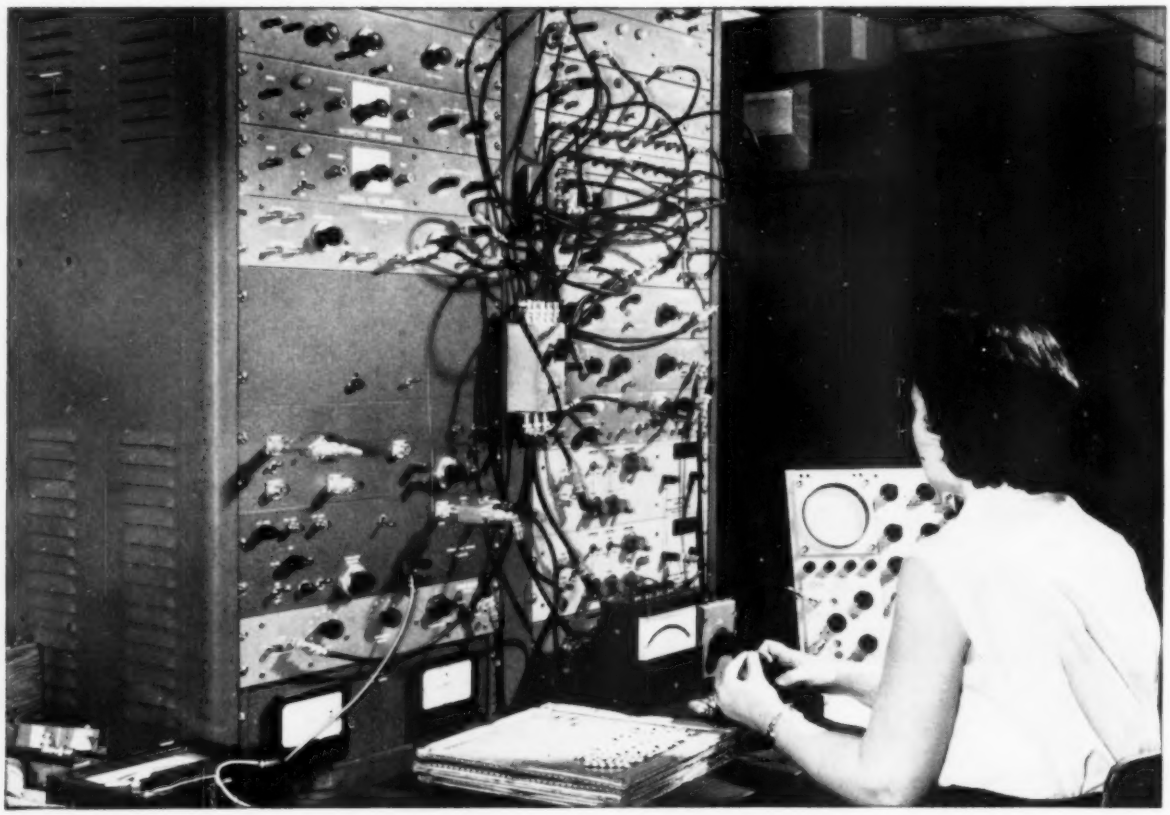

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Take the hundreds of tiny Arnold tape wound bobbin cores that are the heart of some of today's remarkable computing machines.

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Only precision manufacture can assure you this top-quality performance in magnetic core materials . . . and at Arnold *each* core is made and painstakingly checked before shipment by the latest, most thorough methods and equipment.

Some of this testing equipment and many of our production methods were developed by us—for our own use exclusively—and surpass the standards set by the industry. You *know*, when you use Arnold cores, that the materials you receive have met all the rigid standard tolerances, plus any individual specifications you may have.

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WSW 7047

Write for these Technical Booklets

Bulletin TC-108A

"TAPE-WOUND BOBBIN CORES FOR COMPUTER APPLICATIONS"

Includes essential data on applications and properties, fabrication and testing of Arnold Bobbin Cores; lists standard sizes, etc.

Bulletin GC-106C

"ARNOLD MAGNETIC MATERIALS"

Contains data on the complete Arnold line, including cast and sintered Alnico magnets, Silectron cores, tape-wound cores, bobbin cores, Mo-Permalloy and iron powder cores, and special permanent magnet materials.

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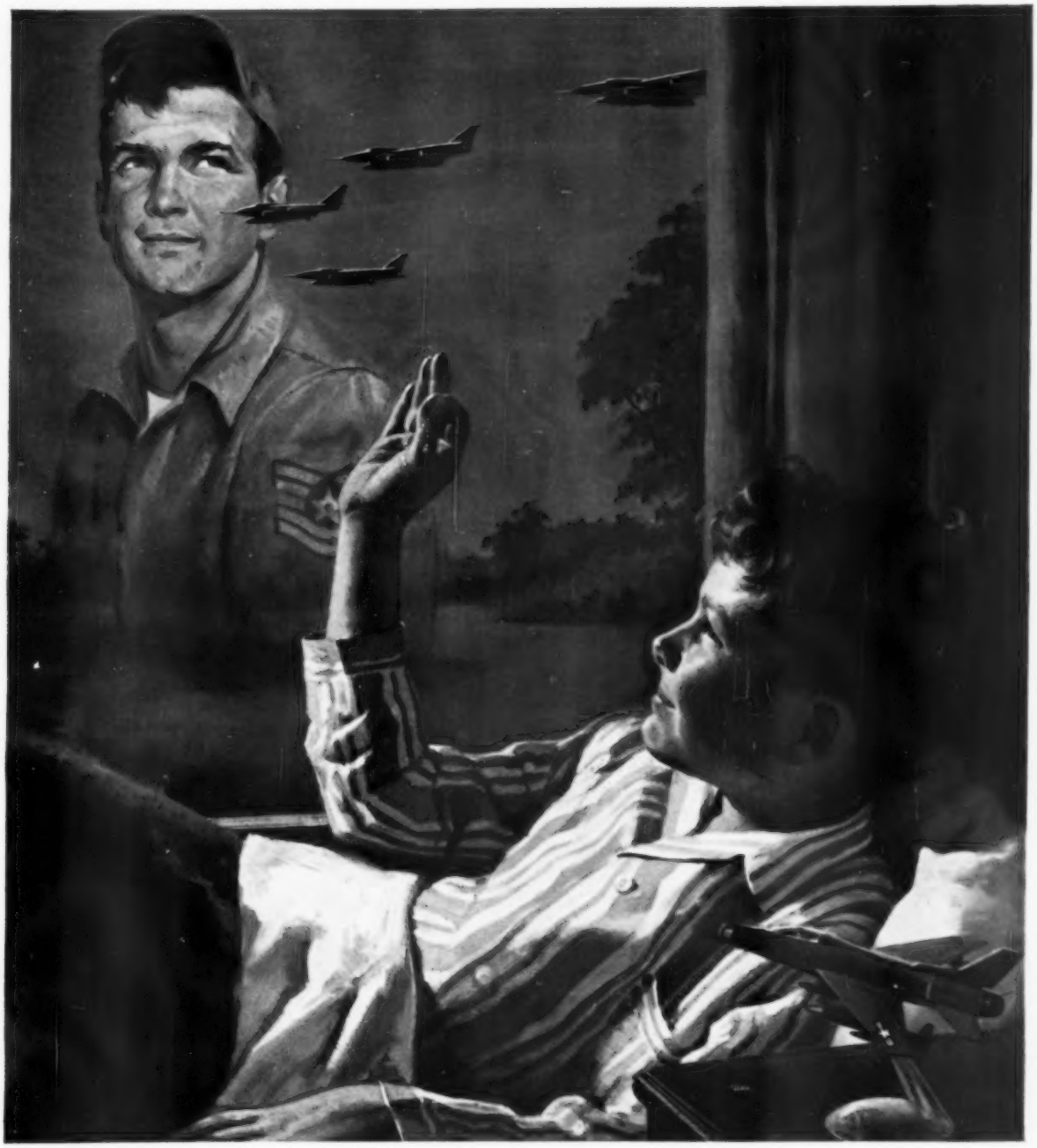

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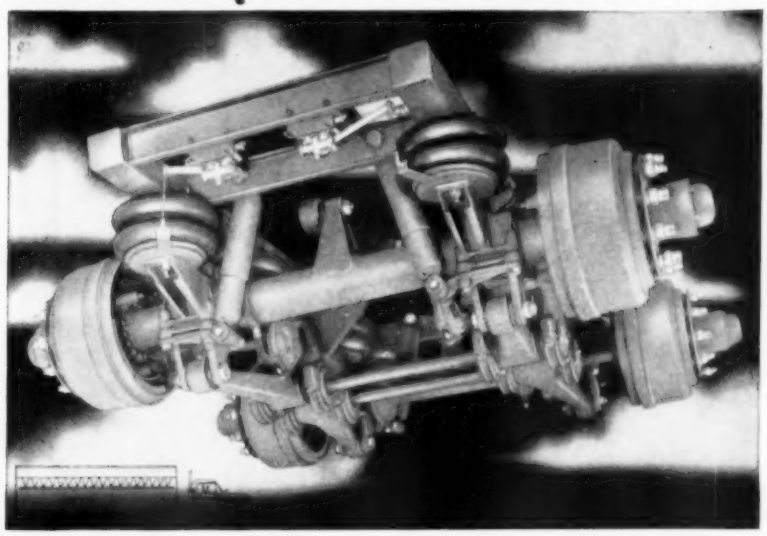


TONS OF CARGO FLOAT ON AIR

with new Clark Air Suspension System for highway semi-trailers

Damage to fragile highway cargo or empty trailers in transit can now be virtually eliminated. Key is Clark Air Suspension. In this new system, doughnut-shaped "air-springs" carry full weight of trailer and cargo. A gentle cushion of air absorbs road shock, literally "floats" cargo and trailer over the bumps with a ride approaching passenger car softness. Empty, for example, a Clark Air-Suspended trailer develops a spring frequency of only 95 cycles per minute; loaded, only 89 cycles per minute.

Lateral roll and sway are minimized by an ingenious system of pivoted torque arms and torsion bars which take the full force of side loads and absorb torsion resulting from brake torque. Trailer loads need no longer be precisely balanced. Offset loading is accommodated by a system of automatic air valving, which feeds and bleeds the air springs to keep the trailer bed level at all times. When loading or unloading trailer, air reservoirs automatically adjust to support bed at normal running height.

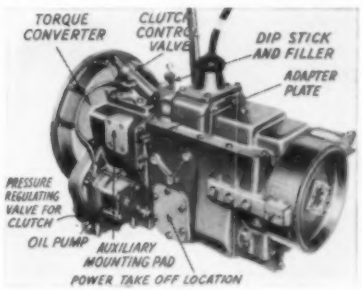
A safety pressure regulator valve, on the line leading from the truck's compressor, is designed to shut off at 60 psi...leaving ample air pressure for the service brake system.

Clark Air Suspension assemblies come as complete packages, ready for installation on new or in-use semis, in single and tandem units. Other advantages include lower trailer maintenance costs and substantial weight reduction possibilities for trailer manufacturers.

NEW POWER TRAIN DESIGNED FOR STOP & GO OPERATION

Designed specifically for off-highway and stop-go operations, Clark Equipment Company's new TransVerter is ideal for such equipment as house-to-house delivery trucks, buses, garbage trucks and various types of construction machinery. Rated for engine torque output up to 325 lb-ft, the TransVerter power train package consists of a torque converter, hydraulic disconnect clutch and standard transmission. Because of its compactness—only 8 inches longer than a conventional transmission and clutch—the TransVerter can often be installed by the original equipment manufacturer without major re-design of his line.

Operational advantages of the new Clark power train include elimination of engine stalling and lugging . . . sharp reduction in gear shifting, to the point where most work can be performed in the same gear . . . fine inching control, simply by working the throttle. Provision is made for SAE power-



take-off attachments, to be driven by the torque converter. The hydraulic disconnect clutch is an off-on type unit that does not require "letting in" or "easing." A variety of clutch releases can be provided, including a shift lever button or a conventional-looking pedal raised slightly from the floorboard.

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Dramatic portrayal, in 24 pages, of Clark's basic line of automotive components. Includes illustrations of the Clark constant mesh and synchronized transmissions, TransVerter, StepMatic, power-shift transmissions, torque converters, agricultural units; also automotive driving and steering axles; planetary, industrial and trailer axles; air suspension assemblies; rear axle housings and electric steel castings.

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A 48-page, full-color booklet in handy pocket size is your condensed guide to the entire product line of Clark Equipment Company. Automotive components, materials-handling equipment, construction machinery—all are described in concise detail. Basic information on the eight Clark plants and brief insight into corporate philosophy make this booklet a "must" for your reading rack.

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As a member of the Army-industry team producing the Nike Hercules (Army Ordnance, Western Electric-Bell Telephone Laboratories and Douglas Aircraft), AiResearch was chosen to design, develop and manufacture this vital accessory power source for the missile because of nearly two decades of experience in lightweight turbomachinery.

This experience includes applications utilizing solid propellants, liquid mono-propellants, bi-propellants, atomic power, cryogenic gases as well as gasoline and air. AiResearch's ability for high capacity production as well as in research and development, made it the logical choice.

Garrett's AiResearch divisions have also designed systems and components for 18 other missiles and rockets in the U.S. defense arsenal.

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MAJ. GEN. JOHN H. HINRICHS

Chief of Ordnance, U. S. Army

REAR ADM. PAUL D. STROOP

Chief, Bureau of Ordnance, U. S. Navy

Coöperation for Defense

Teamwork always has been a mark of Army-Navy Ordnance operations

THE simultaneous arrival on the scene of a new Chief of Army Ordnance and a new Chief of the Navy's Bureau of Ordnance is an unusual event that leads naturally to their dual introduction. They both have served ably as Deputy Chiefs and with such effectiveness that all civilian and military personnel on the working level eagerly anticipated that they would be appointed to their present assignments.

The new Chiefs take over at a time that defies the imagination. While missiles, those weapons that were "Buck Rogers" items ten years ago, are just becoming operational in our fighting forces, the scientific and technical military planners are already discussing space weapons. But technical possibilities mount far more rapidly than they can be turned into usable armaments.

Consequently, both General Hinrichs and Admiral Stroop are faced with the awesome problem of being required to maintain the conventional ordnance of our active armies and fleets at peak effectiveness for immediate action, to replace it as rapidly as funds permit with modernized equipment, and at the same time pour out fantastic sums to develop futuristic weapons that may seem obsolete before they pass the prototype stage.

All three services, in their armament and ordnance operations, coöperate in many areas. As Rear Adm. F. S. Withington recently stated, "There are more than 250 tasks in the guided-missile field being performed by the Bureau of Ordnance for other services." But particularly between Army and Navy Ordnance there is a heritage of close coöperation that goes back at least to early World War II when Lieut. Gen. Levin H. Campbell, Jr., and Adm. W. H. P. Blandy established an effective liaison in the fields of ammunition, fuzes, gun barrels, machine guns, and light armor. Long before the days of single-service procurement, Admiral Blandy and General Campbell often worked together to supply each other's requirements.

As General Campbell so correctly reports in his book, "The Industry-Ordnance Team": "The Industry-Ordnance Team made possible the really magnificent developments that were placed in the hands of our fighting men. . . . In large measure, the same procedure and the same arrangements apply to the Army Ordnance-Navy Ordnance team. We have always believed in and practiced maximum cooperation with the Navy, and this coöperation has been reciprocated in full. We have eagerly fostered this teamwork in every possible way. Knowing something of Navy ordnance, and greatly enjoying working with Navy officers and civilians, we hold naval ordnance in the highest respect."

This type of coöperation has continued on an informal as well as a formal basis over the years and will be continued at the highest level by the two new Chiefs, experienced both in serving their operational forces and developing modern weapons. Even now, they undoubtedly are closing ranks to defend Government laboratories and ordnance plants against proponements of the newly defined weapons system concept, inappropriate to a responsible technical organization that must do business with the entire complex of American industry.

To General Hinrichs and Admiral Stroop the American Ordnance Association offers all its facilities to help them maintain American armament of superior quality and the means to produce it in quantity—and at the lowest possible cost.

Maj. Gen. John H. Hinrichs first served in the Field Artillery after graduation from the United States Military Academy in 1928. He transferred to the Ordnance Corps in 1935, serving at Aberdeen Proving Ground and Frankford Arsenal, and in 1941 took command of the Twin Cities Ordnance Plant.

In World War II General Hinrichs recruited and commanded the Ordnance Maintenance Battalion, 14th Armored Division; then after a tour in the Field Service Division, Office, Chief of Ordnance, he served overseas as Deputy Ordnance Officer, Army Force, Pacific Ocean.

Postwar, General Hinrichs completed the National War College course, served two years in the Joint Staff, and returned to the National War College on the staff and faculty.

Reporting in December 1951 to the Office, Chief of Ordnance, he was deputy, then chief of the Field Service Division, then Deputy Chief of Ordnance. He took the oath of office as Chief of Army Ordnance on April 3, 1958.

Rear Adm. Paul D. Stroop, Naval Academy graduate in 1926, qualified as a Naval aviator in 1929.

Until 1942 he served at sea in torpedo and bombing squadrons, in carriers and in cruiser scouting squadrons, and ashore in the Bureau of Aëronautics of the Navy Department.

In World War II he served on carrier staffs, Adm. E. J. King's staff, and in command of the seaplane tender, MACKINAC, and the escort carrier, CROATAN.

After duty on fleet staffs in the Pacific through 1946 to 1948 and a shore tour, he commanded the PRINCETON and later the ESSEX in the Korean war.

In recent years Admiral Stroop commanded the Naval Ordnance Test Station, China Lake, Calif., was senior naval member, Weapons System Evaluation Group, and Deputy Chief of the Navy Bureau of Ordnance. He commanded the Taiwan Patrol Force just prior to taking over as Chief of the Navy Bureau of Ordnance on March 14, 1958.

Regulus II test vehicles (Navy photo).

No Ultimate Weapon

Maj. George Fielding Eliot

"A STUDENT of military history," said an Army friend to this writer the other day, "might as well go and drown himself for all the attention he is likely to get in this space-and-sputnik era."

He was sadly right. For years we have been told, over and over, by all sorts of scientists, journalists, and even novelists, that the nuclear bomb is "the ultimate weapon"; that it makes all other weapons obsolete and likewise makes nonsense of the time-honored principles of strategy; that anybody who thinks otherwise is just whistling as he passes the graveyard.

Under the influence of the current missile madness, compounded by proposed journeys to the moon for the purpose of there establishing a base for space-rocketry, this idea of the ultimate weapon is fast settling into a fixed conviction. It does not seem to occur to very many Americans that man's great adventure into interstellar space has to start from somewhere—that is, from the surface of this planet, Earth—and will be controlled by whoever controls sufficient of that surface and the attendant resources in manpower and material to accomplish it.

If the Soviets control Earth's surface, they will be the pioneers of space-travel and receive the acclaim of future generations, duly couched in phrases suitable to the Marxian dialectic. While they are thus pursuing the paths of glory, the rest of us will be having an unhappy time right here.

We might as well wake up to the sad fact that we have been sold a bill of very dangerous goods. As the editors of ORDNANCE remark in the January-February 1958 issue, we have "become unwittingly and with our eyes wide open the victims of a psychological warfare in which we are daily proving ourselves to be more gullible."

The Kremlin never neglects to combine the political, military, and psychological aspects of its policy initiatives, seeking progress on all these fronts and coördinating each toward the achievement of the common objective.

THE immediate objective of their missile program in the psychological field appears to be (1) to create the impression in the United States that the fixed-base ballistic missile married to a nuclear warhead really is "the ultimate weapon" which makes everything else obsolete; (2) to create the impression not only in the United States but throughout the world that the U.S.S.R. has so impressive a lead in the development and production of this ultimate weapon that it cannot be overtaken, at least for a considerable period of time, which means that for *X* years we shall be living in a world in which the U.S.S.R. has a position of decisive military superiority.

Of course, this is an oversimplification. There are various side lines and intermediate objectives, as usual.

For instance, since we have gratifyingly responded as the Kremlin expected by a frantic scramble to "catch up" in the ballistic missile race, we have come smack up against the technical fact that we, like the Soviets, will have operational intermediate-range missiles before operational missiles of intercontinental range become available.

There has followed, as the Kremlin doubtless foresaw, another frantic scramble to establish our forthcoming intermediate-range missiles in the only launching sites from which they could reach Soviet targets; that is, sites on the territory of our NATO allies in Western Europe. This has turned out to be duck soup for every opposition party in every allied government.

BY our very insistence and urgency, we have gone a long way toward convincing the peoples of these countries of the validity of the Kremlin's claim that ballistic missiles have made all other delivery systems for nuclear weapons obsolete. Only yesterday they thought they were safe under the deterrent umbrella of the Strategic Air Command. Now, it seems, there are holes in the umbrella—otherwise why are the Americans so desperately anxious to establish missile bases alongside their airfields?

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The disruptive effect of the resulting political debates on the solidity of NATO need hardly be argued—it is self-evident. From the viewpoint of startled Europeans they are not only losing the protection of American retaliatory power, they are being asked further to endanger themselves by emplacing missile sites in their own bosoms in order to defend America.

This is not only duck soup for the various opposition parties—whose leaders have no more hesitation in making partisan capital of such problems than do our own politicos in like cases—it is also duck soup for the Soviet leadership, which is happily keeping the trouble-pot boiling by a judicious combination of dire threats as to the consequences of accepting American missiles and sirupy suggestions about summit talks and an atom-free neutral zone across the center of Europe.

All these troubles arose from our hysterical reaction to the sputniks and their spectacular demonstration of the scope and progress of Soviet ballistic missile development. We were already conditioned to accept unquestioningly the phoney theory of "the ultimate weapon." We had been rocking along on comforting assurances that the enemy wouldn't have this weapon before we did, and anyway not for some years to come. Then—bang!—across the clear sky of our complacency, came the symbol of dread reality.

A lot of good it does, as my Army friend said, for people such as he (or the writer of these words) who have grown gray in the study of strategy and military history to point out that all this is being done with mirrors, that it is an illusion which can be dissolved by firm adherence to a sound and balanced arms policy. Well, all we can do is to keep trying.

The first thing for anxious Americans to keep in mind is the map of the world—displayed on a globe. If only every American family could be sold the idea of having a globe and looking at it thoughtfully once a week, the foundations of our military security would be more firmly established.

The globe shows the continent of North America as an island surrounded by water—an island which faces east toward the Atlantic Ocean, west toward the Pacific, and north toward the ice-bound Arctic.

The Soviet Union, by comparison, is landlocked. It has a longer Arctic frontage than we do, but only restricted access to freely navigable seas.

GEOGRAPHICALLY, we are relatively mobile because we can use the sea and the air space above it; we can establish outlying bases for sea and air weapons; we can send help to our friends quickly and economically. These friends include the inhabitants of the "rimlands" of Europe and Asia, all around the perimeter of the Communist land mass.

Therefore the basic principle of our national strategy must be mobility. Since strategy is sterile unless the tactical means exist to carry strategic plans into execution, it follows that our armaments should emphasize our geographical advantages and have mobility as their basic quality.

By contrast, the facts of geography render the Soviets relatively immobile. In their case, geography is reënforced by the totalitarian character of their political institutions, which require tight control of all national activities from the "summit." For such a regime, so located and bent upon expansion of its power by force and the threat of force, fixed-base ballistic missiles of increasing range are ideal weapons both for blackmail and for actual war. They can be controlled closely, unlike sea-based weapons or long-range piloted aircraft. Their sites can be concealed and can be prepared for firing with a minimum of visible preparation, hence a maximum of surprise. Their qualities thus fit the characteristic aptitude of a

police state for concealed decisions and surprise execution.

But the adaptability of this type of missile to the military requirements of the United States is far more doubtful than one would imagine from the clamor about the need for "catching up" in its development. Certainly we must be able to maintain a level of deterrent (*i.e.*, retaliatory) nuclear firepower sufficient at all times to impose a prohibitive risk on Soviet nuclear aggression.

It is an essential quality of this retaliatory force that it should be relatively immune to destruction or neutralization by surprise attack. Since the Soviet missiles have been specifically designed to neutralize the fixed bases of the Strategic Air Command, can we really say that the proposed new fixed launching sites for our own ballistic missiles have any greater degree of immunity than the SAC bases?

To ask this question is to suggest how little our response to the Soviet missile threat was inspired by either strategic or tactical imagination and how much it was sheer political reaction to popular excitement.

We must do *something*. We must do something *now*. At least we must *appear* to be doing something now. They have missiles. We must have bigger missiles, or anyway equivalent missiles.

Such, in essence, seems to have been the kind of thinking that gave birth to our present program of overseas IRBM sites which is tearing the North Atlantic Alliance apart and holds small promise of ever tearing anything in the Soviet Union apart, either psychologically or physically.

But if not IRBM's in Europe, then what?

There is hardly space in this paper to develop proposals for a full-scale counter-deterrent program, but one suggestion may indicate the manner in which *mobility* and *existing weapons systems* might be applied to the problem before us.

The Navy is just putting into production a guided missile called Regulus II, produced by Chance Vought Aircraft, Inc. Regulus II is not a ballistic missile; it is a winged, air-breathing guided missile, powered by a turbojet engine. Before I am told to go get my bow and arrow, let's look at some of the other qualifications of Regulus II.

It has a speed of Mach 1.7, or something over 1,200 miles an hour. It has a range of 1,500 miles and in later models is expected to reach 2,000 miles. It can carry a high-yield nuclear warhead. And it has what amounts to pinpoint accuracy compared with any ballistic missile of comparable range yet produced by anybody—a CEP (circular error probability) of less than one mile at extreme range.

It can be fired, with boosters, from submarines or from the decks of surface ships. Several cruisers and submarines are now in service or coming into service which are fitted to handle it. Moreover, it can be fired *without boosters* from the steam catapults of all our modern or modernized aircraft carriers. Any such sea base, as far as the landlocked Soviets are concerned, is a firing point of unknown location.

To the writer's bow-and-arrow mind, this weapons system is a form of deterrent power which takes full advantage of our worldwide mobility, which will be ready within the immediate future, which endangers no civilian populations (ours or those of friends) by its deployment, which is virtually impossible to stop once it is on the way, and which can be used, if necessary, on the sole decision of the constituted authorities of this country without asking anyone else's permission.

There are other sea-based weapons systems coming along which also can be applied to our need for a nuclear deterrent, with similar advantages based on mobility and, of course, surprise.

The Air Force is producing some new aircraft, too; so is the Navy, for carrier operation. We might remember that whether we are talking of missiles or of aircraft, any weapon which can be used from a mobile sea base is *ipso facto* possessed of intercontinental range.

"Our best chance of deterring or defeating limited aggressions is to be found in the creation of forces and weapons systems which will be equally well suited to exploit our geographical advantages as well as to achieve our ends."

But what about "limited war"? One aspect of the current situation which has been much enlarged upon is the possibility that, as Soviet missile power grows, the Kremlin will imagine that it is acquiring greater freedom of action to go ahead with limited-liability enterprises of various sorts, with the cumulative purpose of nibbling the free world to death.

At any rate, they are still keeping up a much larger army than we are, with a very much larger backlog of trained and equipped reserve formations, and they are equipping this army with a formidable array of new weapons in the armor, artillery, and missile categories.

We are allowing our Army to be reduced progressively in combat strength and are even hacking away at the troop level of its reserve components—the Army National Guard and the Army Reserve.

The theory behind this has been monotonously reiterated: Modern weapons (especially atomic weapons) allow us to get more firepower with fewer men. This process can readily reach the point of no return.

We are also told that since there is no intention, in any future war, to oppose the Soviet hordes on a body-for-body basis, we do not need a large Army. We just need an Army capable of dealing promptly with "limited war" situations, plus plenty of atomic weapons in case we become embroiled on European battlefields.

This is altogether too, too, simple. If we need an Army capable of dealing with limited situations anywhere around the Communist perimeter, we should try to derive decisive advantage not so much in superior armament (though this is useful) as in superior strategic mobility. We haven't provided the instruments for this purpose, but we go on cutting down the Army just as though what was left could be moved

The long-range C-133A turboprop transport is a vital part of our strategic airlift, necessary to move men and materiel rapidly in emergencies (Air Force photo).

twice as fast as last year. It should, it seems to this old-fashioned mind, be axiomatic that, when the object is to produce a superior concentration of force at a location on the perimeter of a huge land mass ill-provided with internal means of movement, the advantage of the superior mobility of sea-air transportation should be exercised to the fullest possible degree.

Experience warns that in emergency situations of this sort, time is the factor of primary importance. To exploit our geographical advantages, we require strategic airlift, means of acquiring and readying emergency air bases, mobile tactical air power, troop units equipped and trained for air transportation, and means (such as helicopters and ships to operate them) for the ship-to-shore or airbase-to-combat-zone movement of troops and supplies and the tactical deployment of the troops under favorable circumstances.

Most of these means we have, though in some cases nowhere nearly enough. Thus we are producing the C-133 long-range troop and cargo transport aircraft in driblets. We are reducing the Army, and doing nothing to make the remaining units more effective for foreseeable needs.

The writer does not mean to imply that the presently programmed reductions of the Army would be justified if we just speeded up the production of C-133's. The Army's troop level and that of its Reserve components has been cut well below the safety point. But to do this, and then also fail to provide the existing forces with the requisite mobility to enable their timely deployment on a global basis, displays a complete disregard of any relation of our strategic interests to the time-tested principles of strategy or to our geographical and political circumstances.

Suppose that the Soviet "ultimate weapons" are balanced by our creation, in one form or another, of "ultimate weapons" of our own, so that in Moscow as well as in Washington all-out nuclear war becomes unacceptable as an instrument of policy. Does it follow that the Kremlin is thereby also deterred from limited and localized aggressions—perhaps by proxy, with "peoples' volunteers"? They were not so deterred in Korea, during the days of our virtual monopoly of nuclear weapons and long-range delivery systems; why should they be deterred in a period of relative nuclear power balance?

Surely our best chance of deterring all-out war does not lie in seeking a balance based on a mutual confrontation of fixed-site missile systems; that is, in rushing to adopt the enemy's chosen weapons without ever asking ourselves whether other weapons are better adapted for our purposes and could, indeed, produce not merely a balance but rather a decisive superiority for our side.

And surely our best chance of deterring or defeating limited aggressions is similarly to be found in the creation of forces and weapons systems which will be equally well suited to exploit our geographical advantages as well as to achieve our ends.

As the editors of Ordnance truly say in the editorial already referred to, "It will be of slight consolation when a psychological war becomes real to find that except for missiles and rockets all the other necessary components of our arsenal have become obsolete."

Toxicological Warfare

We must know how to detect and neutralize chemical, biological, and radiological weapons since their effects against personnel rather than matériel offer distinct advantages to an enemy attacking us

Maj. Gen. William M. Creasy

THE elements of a sound national security program must include adequate provision for four things: deterrence of general war, deterrence of local aggression, defeat of local aggression, and, if necessary, victory in general war conducive to a workable peace.

Three times in the past forty years we have paid a high price for our lack of preparation for war. We have learned that in a world where strength is the only deterrent recognized by an aggressor, the surest guarantee of peace is constant preparedness for war.

Today we are devoting much time and effort to prepare for the possibility of nuclear warfare and to perfect our defenses against it. While the Army emphasizes the attainment of a fully effective capability to conduct atomic and thermonuclear warfare, ground forces are being organized and equipped to retain a capability to win wars in which nuclear weapons are not used. They are being trained and equipped to be capable of applying force in varying degrees commensurate with the varying situation.

In our military preparations we must be ready for any possibility. The Army's official position is that it must be prepared to engage in any type of war, limited or unlimited. As nations approach equality in particular weapons systems, the search must begin for systems in which such equality has not been reached.

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All warfare is antipersonnel in nature, no matter how it is accomplished, for without manpower machines and weapons become inoperable. The weapons systems included in the so-called toxicological fields of chemical, biological, and radiological warfare—commonly known as CBR warfare—are primarily antipersonnel in nature. They are known as minimum-destruction weapons as opposed to those weapons which destroy material objects as well.

Because these weapons offer distinct advantages to an enemy in an attack against the United States, they can be considered a logical complement or a possible alternative to the use of nuclear weapons in any future conflict.

One reason that CBR weapons might be considered for use against us instead of the tremendously destructive thermonuclear weapons is the very fact of that vast destruction. Military attacks are not necessarily undertaken to destroy but to occupy territory for which the occupier foresees a use.

We must recognize that an enemy bent upon total conquest could be expected to use any means which would serve his ends. If an enemy felt that it might be possible to render the United States impotent as a fighting force, and at the same time preserve our industry for his own future use, we can expect that he would use any means that could make this possible. For this reason CBR munitions take on a new meaning in any forecast of the types of warfare an enemy might consider for possible use against this country.

TO be of use to an enemy, our steel mills, machinery-producing plants, and the many other factories that an enemy could use for his own benefit, would have to be intact when the war ended. The selected use of CBR weapons could achieve this result.

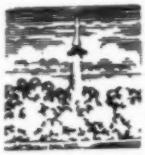
To assist in our own appraisal of these forms of warfare we should look through an enemy's eyes at some of their principal advantages and the factors which might lead to their use against us.

The United States, it will be recalled, did not use this type of warfare in World War II. At the outset of that conflict we announced that chemical warfare would be used only in retaliation for similar attacks upon ourselves. But our potential enemies have already openly announced that their planning for the next war includes the possible use of CBR weapons.

These agents have much in common. They cannot ordinarily be detected by the human sensory organs. This gives them great surprise value. They can

circumvent—or in the case of radioactivity, penetrate—normal means of protection against explosive-type munitions. They are flexible in that the user can control the effect upon the victims through choice of an agent which may either incapacitate or kill.

The agents in the chemical, biological, and radiological groups often can debilitate without the victim being aware of it. Further, they cause no destruction of buildings or machines. While a rifle bullet or high-explosive munition loses its effectiveness within seconds after being set in action, the CBR munitions may pose a health problem for periods ranging from minutes to days.



The latter would be particularly true in the case of biological weapons. These weapons could be very attractive to an enemy aggressor for use in a softening-up process before any actual attack was launched. They can be ideal sabotage agents. The air-conditioning and ventilating systems of large buildings are ideal methods of distributing these agents to large numbers of people. Sabotage could be far-reaching in its effects by distribution through our enormous food-processing systems.

A consideration which could be very tempting to a potential aggressor is the fact that the use of CBR warfare could considerably reduce an enemy's own losses. The utilization of CBR munitions permits the covering of large areas to military advantage with a minimum of logistical effort. This greatly reduced expenditure of material and industrial resources, as well as personnel, is a further advantage of these weapons which might appeal to an aggressor nation.

IN addition, the effectiveness of CBR munitions could influence an enemy to use them. United States casualties in World War I showed that a man wounded by gas had a fourteenfold better chance of survival than did a man hit by flying lead or steel. However, a nonfatal casualty needs five or six other people to care for him during the convalescent period, while a dead person is no such liability.

This drain upon manpower reserves could be an important factor in the decision of an enemy to use a nonfatal type of chemical, biological, or radiological munition against U. S. military forces or civilian communities.

Chemical warfare is an elastic term that embraces not only the use of toxic chemical compounds (gas warfare) but also the military use of flame, incendiaries, and smoke in warfare. The military use of flame warfare, incendiaries, and both signaling and screening smokes has become an accepted part of Army combat operations. Toxic chemical compounds, commonly referred to as war gases, have not been used since World War I but could be used against us in a future conflict.

Because the first modern use of toxic chemicals occurred in World War I, when the Germans employed chlorine gas, all such use of chemicals has been termed gas warfare, although in many instances the compound may actually be dispersed in other forms.

Basically there are six types of toxic agents: tear gases, which cause crying and sting the skin; vomiting gases, which cause severe nausea; choking gases, which cause congestion of the respiratory system; blister gases, which inflame and blister any part of the body with which they come into contact; and blood and nerve gases, which upset normal body cellular reactions to the point where paralysis may result.

The tear and vomiting gases are considered as harassing agents since they produce effects not ordinarily lethal and which pass off within a few hours. The blister, nerve, and blood gases are considered lethal agents since they can cause death. However, ordinarily only exposure to heavy concentrations results in death, and exposure to light doses may merely debilitate a person for periods ranging from days to weeks.

Biological warfare is the deliberate use by man of microörganisms to cause disease and possibly death among humans, animals, and plants. By his choice of a disease agent, the initiator of a biological warfare attack could decide beforehand the results he wanted to achieve: death to humans, incapacitation of people for long or short periods, or destruction of man's food supply in the form of livestock or crops.

THERE are a great many disease agents from which an enemy could make his selection for a specified military purpose. He might choose an acutely debilitating agent, a chronic disease producer, or one causing a high rate of death. It is entirely possible that certain mutational forms may be produced which have strong resistance to drugs or which make identification difficult.

However, it is not likely that entirely new agents of unique virulence or new

Army Chemical Center soldiers demonstrate the new E13 mask designed to protect against chemical-biological warfare agents and radioactive fall-out (Army photo).

disease-causing capacity may be produced, even though the world has made remarkable progress in producing bacterial transformation in recent years.

The nature of biological warfare permits a great flexibility in methods of delivery of a biological agent. Effective employment is possible by means ranging from use by saboteurs against selected installations to mass delivery over large areas by airplanes, submarines, and missiles.

Radiological warfare is the intentional scattering of radioactive material—such as dust, for instance—on a specific target. The effects would be the same as those resulting from the natural fall-out of a nuclear detonation. And, like chemical and biological warfare, the effect could vary from temporary illness to death, depending upon the amount of radiation to which a victim was subjected.

With this type of warfare, an enemy could cause short-term or long-term contamination and denial of large areas, depending upon the means of contamination and the material employed. When distributed by small bombs dropped from planes and missiles, there would be little or no attendant destruction of facilities.

These, then, are in general the threats which CBR warfare poses against the United States in the event of a future conflict. It is necessary for us, therefore, to have a capability in these weapons systems as well as to have adequate defenses against them. In CBR warfare, as in other types of warfare, the strongest deterrent to its use could well be our retaliatory capability in that field.

DURING World War II, the Germans developed nerve gas and had huge stockpiles of it available for use against the United States and her allies. Fear of our retaliatory capability in the field of chemical warfare was a major deterrent force in preventing a gas attack upon our troops by the German Army during that conflict.

In addition to this need for a retaliatory capability in these fields, it is necessary to investigate all possible new weapons and agents in order to develop adequate defenses against them.

The development of means of defense against CBR munitions is an important phase of the work of the Army Chemical Corps. As the only agency of its kind in our government, the Chemical Corps must carry out the research and development, the procurement or manufacturing, the storage and supply, and certain phases of training to provide a defensive capability not only among agencies of the Department of Defense, but also those such as the Federal Civil Defense Administration and the U. S. Public Health Service.

The Corps works closely with the Federal Civil Defense Administration in the adaptation to civil-defense use of ideas and items developed by the Chemical Corps for the protection of troops.

Matérielwise, today we have reason to believe that we have the means to defend ourselves against the CBR weapons. But, mentally, we are not so well prepared. It is not generally recognized that these are weapons-in-being and that they are just as likely to be used against us as the nuclear weapons. There still exist some gaps in our thinking regarding the realities that face us. It would not do us much good to survive an atomic attack only to fall victim to a subsequent toxicological attack.

Defense against CBR attack will not be purely a military job, for both the civil community with its industrial complex and the military forces are probable targets of such an attack. Adequate defense will entail the coöperation of all citizens and industries in a well-organized civil-defense effort in every community in the Nation in addition to planned CBR defenses for our military organizations.

The nature of these weapons points to their effectiveness when used by an aggressor to paralyze a nation's productive effort by an attack upon key industrial centers and the communities surrounding them. Equally effective use could be made of these weapons in an attack upon our key military supply points to reduce the striking power of field units dependent upon these sources for food and munitions.

Military and civil-defense planning for possible CBR attack must be integrated with plans against nuclear attack, for an enemy may choose to use nuclear weapons alone or in conjunction with toxicological attacks. Important to remember in our total defense planning, including both civil and military phases, is that in case of attack the community must be able to depend upon its own resources for the protection of its citizens.

Since many of the measures and items of protective equipment developed by the Chemical Corps have application to civil-defense uses, such measures and equipment are made available to the Federal Civil Defense Administration for adaptation to civil-defense needs.

The first problem of defense against CBR attack is the detection and immediate identification of the type of agent or agents being used in an attack. This is not simple, since the agents in these fields are not easily detected and since different detection methods must be used for chemical, biological, and radiological agents.

FOR chemical gas attack there are automatic alarms which give a visual or audible signal when the mechanism detects minute quantities of gas in the air. Gas alarms have been developed which detect not only the conventional war gases but also the new nerve gases.

These alarms are of two types: large ones for permanent installation to buildings, such as those presently used by the Chemical Corps in some of its industrial arsenals; and smaller, portable models which could be used by mobile troop units. Identification sets requiring very little training to operate have been developed to identify quickly the type of gas agent being used.

The aërosoloscope, developed by the Chemical Corps and industry, can assist in giving the alert that an attack may be under way. This device operates on a light-reflection principle, rapidly counting microscopic airborne particles of moisture, dust, or germs, and indicating the presence of foreign matter in the air.

In the case of biological warfare agents, the mere knowledge that an unusual amount of bacteria is in the air

is not enough. For all air contains bacteria, some harmful, some not. Routine hospital and laboratory methods of identification require from two to four days.

Working with an industrial firm, the Chemical Corps has developed a filter which makes it possible to trap bacteria in large quantities and identify their type within hours. Early identification by this method makes it possible to treat exposed persons—if the germ is a disease agent—and to take necessary steps to protect other people in the critical area through mass innoculations and other health measures.

In the radiological field, dosimeters are used to measure the amount of radiation to which a person may have been exposed. Several types have been developed by various military agencies, among them the Signal Corps' quartz-fiber dosimeters and the Navy's crystal dosimeters. A recent development by the Chemical Corps is the chemical dosimeter which measures neutron and gamma radiation. This dosimeter works on a liquid chemical color-change principle and is very easy to read, making it particularly useful to troop units.

Detection and identification of CBR agents would be of little use without adequate measures and devices to protect the individual. Of primary interest both to the soldier and his commander are means of individual protection.

The primary means of such protection is the protective mask. A new mask for troop use has been developed recently and is undergoing final tests before being standardized for general troop use. A major feature is the absence of the bulky canister employed on current models. Instead, a new lightweight, pliable filter material enclosed in cavities in the facepiece of the mask provides protective qualities.

The new mask has many important advantages over types now in use, such as lower breathing resistance, better speech transmission, superior vision, and greater comfort. It is designed to give the soldier complete protection against the inhalation of chemical and biological warfare agents and airborne radioactive fall-out particles.

In addition to this new protective mask, various special masks have been designed and developed by the Chemical Corps. A mask was developed for use by the Navy on shipboard to meet special requirements of that type of duty. Various special masks have been designed for use in military hospitals, such as a mask for use by patients with head injuries and a six-person collective protector for bedridden patients who could not be moved to a shelter area in case of CBR attack.

The portable automatic nerve-gas detector alarm weighs about 25 pounds, can operate continuously for 12 hours, and carries its own filtering system for heavy dust or smoke conditions (Army photo).

In addition to the protective mask, protective clothing has been developed, as well as methods to treat ordinary military field clothing to make it less permeable to various CBR agents.

In addition to these items of protective equipment, there have been developed means of individual treatment in case of exposure to toxic agents, including atropine syrettes for immediate treatment of nerve gas. Recently, a new chemical compound has been discovered which, when used with atropine, provides for faster recovery from nerve-gas effects. Chemical Corps scientists are quick to point out however that this does not spell the end to the quest for further improvements.

In the biological warfare field, new methods of immunology are the subject of constant research in order to develop the necessary vaccines and serums to provide troop protection against all possible agents. One goal of this research work is the development of a one-shot immunization against several diseases.

Continuous research and development are being carried out by the Army Chemical Corps today in the fields of toxicological warfare to ensure our capability in these warfare systems. The challenge of CBR warfare to our Nation today might well be summed up by pointing out some of the things which need to be accomplished:

1. There must be a general realization that the CBR weapons pose a hazard to our national welfare just as do the nuclear weapons.

2. Secondly, the mystery with which these munitions have been surrounded must be removed so that our understanding of their nature and effects will not be clouded.

3. Defense measures which the Chemical Corps has developed for the military must, in addition to being an integral part of military training of all units, be incorporated in our civil-defense planning wherever feasible.

4. We must achieve and maintain strength in the CBR field so that an aggressor will not be tempted to use these weapons against us.

The day when we can realistically say that our military and civil-defense planning against toxicological attack is on a par with our atomic defense system—that our means of total defense is on a par with the enemy potential of offense—that will be the day when we will have achieved a CBR strength that can serve as a useful tool in engineering world peace. For it will have removed one more area in which an enemy could make a profitable attack.

Air Force Missiles

The new guided weapons, in combination with manned systems in use today and planned for the future, will provide integrated and flexible air power of even greater strength for America's defense

Maj. Gen. J. W. Sessums, U.S.A.F.

THE year 1957 was a significant and fruitful one in the Air Force guided-missile program. Sputniks notwithstanding, we can be proud of the milestones passed during 1957—milestones made possible by the successful operation of the Air Force-Science-Industry Team.

Among these are the full-range tests of the Snark intercontinental missile and the activation of an operational unit in the Strategic Air Command for its employment.

Also of note was the activation of SAC units employing the Rascal, an air-to-surface missile of high performance, which significantly extends the effectiveness of the B-47's with which it is employed.

In the ballistic missile program we also have seen heartening progress. From a discouraging and inauspicious start, particularly as far as public confidence in the program was concerned, we have seen five of the six Thors launched successfully. Moreover, four Atlas missiles were launched, the last two being perfect flights, fully achieving their test objectives.

BUT before we get ahead of ourselves, let's review the Air Force program in its over-all philosophy and context.

For many years, and particularly since World War II, Air Force thinking has realistically taken into account the potentialities of guided missiles in future Air Force operations. As these new systems have proved and demonstrated their capabilities to do a reliable and effective job in combination with or complementary to manned weapons systems they have been introduced into the Air Force inventory. Witness the Matador, Falcon, Rascal, and Snark.

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I mentioned that our thinking in the area of guided missiles is not new. Actually, it goes back to World War I when a group of air enthusiasts, including Orville Wright and Lieut. "Hap" Arnold, successfully launched our first guided missile—a "flying torpedo" as they called it. This device was a small airplane which carried an explosive charge and was equipped with a primitive short-range guidance system.

A sophisticated and complex guided missile of today is the Martin Matador which has been operationally deployed in Europe for several years and now is also stationed in Taiwan. The Matador has been further developed into the TM-76, or the Mace.

To give this missile an additional capability for training our operational personnel, a recovery system has been devised in which parachutes are used to recover the missile. These particular tests were carried on at the Air Force Missile Development Center at Alamogordo, N. Mex., and illustrate the importance of an overland range in recovering test vehicles and missiles.

As the missile approaches the ground, inflatable bags underneath are blown up. The missile is lowered gently and is recovered intact. Although some minor damage may have been incurred, the missile can be repaired easily and made suitable for reuse. This development makes possible a cheap and effective training program for our tactical air units.

ANOTHER important missile already in operational use is the Falcon, a guided aircraft rocket. The Falcon, together with smaller unguided rockets, comprises an armament load for the Convair F-102, the latest of our high-performance air-defense interceptors to go into operational use.

The F-102, a new supersonic interceptor, is now in action. This aircraft is matched by the new and modern Falcon missiles which it employs. The Falcon is launched and guided to the target by either a radar homing system or an infrared homing device.

In the air-defense rôle our objective is to make interceptor weapon systems more and more automatic. The Bomarc interceptor missile or Boeing IM-99 approaches the ultimate in automaticity and is being integrated into the complex Sage system. It is being programmed to attack from a higher altitude.

Although the Bomarc is launched by a liquid rocket, it is propelled over the major portion of its flight profile by two ramjet engines. The Lockheed X-7, a ramjet test vehicle, was quite important to us in getting answers in this engine development program.

THE X-7 is taken aloft by a carrier aircraft and then launched. A solid booster rocket pushes it up to speed so that the ramjet can take over and accelerate the vehicle to operational speeds. During recent months one of the ramjets being developed by the Marquardt Aircraft Company reached a record speed of Mach 3.95.

An important feature of the X-7 is that it can be recovered by parachute. One photo of the vehicle after recovery is quite interesting because it looks like it just came out of a waffle iron. The missile was scorched by the high skin temperatures generated during this particular flight. This test program has given us the ramjets for the Bomarc.

The Bomarc interceptor missile has been in the flight-test program for several years, and the results have been gratifying. These tests have been conducted at ARDC's Air Force Missile Test Center, Patrick Air Force Base, Fla. The Bomarc missile is essentially an airplane without a pilot. The missile incorporates an automatic seeker device in the nose which guides the missile to a target kill.

The Bomarc is launched by a large liquid rocket engine located in the fuselage. After the rocket engine has been expended, two ramjet engines continue to accelerate the missile to a high supersonic speed and propel it at long range to its target.

Another development milestone was reached recently when a production prototype Bomarc was automatically launched by a controller more than eighteen miles from the launching site, and the missile successfully intercepted and destroyed the drone target more than a hundred miles away.

FOR strategic air operations, a missile approaching operational employment is the Rascal. The Rascal, or GAM-63, built by the Bell Aircraft Corporation, is a missile which is launched from a manned bomber at a distance from the target. Its rocket engines then take over and propel the missile to the target at high altitude and supersonic speed.

The Rascal is a harbinger of things to come in the area of air-launched offensive weapons. A new air-to-surface missile of much greater range than the Rascal is now being developed by North American for employment with the B-52. We are moving along the line of developing a highly mobile and fast-moving strategic force that is constantly in the air and armed with the most potent weapons that we can devise. Beyond the Rascal and the new ASM (air-to-surface missile), future weapons will be air-launched ballistic missiles using stable, lightweight, and easily handled propellants.

The major advantage of such an airborne force is that it will be responsive and quick to react to a threat of attack. Patrolling in air and eventually in space, it can be swiftly directed to enemy sites which may be launching offensive thrusts against our Nation or our allies.

A MAJOR contribution to the evolution of such a force is the development of nuclear-powered aircraft—a goal toward which the Air Force and the Atomic Energy Commission have made progress in the past several years.

Turning to the surface-launched intercontinental missiles, the first to come to the test and operational stage was the Northrop Snark, or SM-62. The Snark is entering operational use.

The Snark's large booster rockets fall away after they have been expended, and a turbojet engine powers the missile at a subsonic speed to the target. The Strategic Air Command has already activated a Snark unit.

This weapon system will accurately deliver a nuclear warhead on its target and, while not as glamorous as the ballistic missiles, it is an important addition to the family of weapons systems which comprise our effective deterrent airpower of today.

We shall now discuss the Nation's highest priority program—the ballistic missile. The Air Force development activity in this area includes three missile programs. Two, the Atlas and the Titan, are intercontinental ballistic missiles

Above, Atlas service tower is viewed through periscope on blockhouse, Cape Canaveral, Fla.

Above, secured to a static test tower, a liquid-fueled rocket motor is tested for amount of thrust. Below, another testing tower is used to accumulate further information concerning rocket motor and fuel (Air Force photos).

with ranges of 5,500 nautical miles. The third, the Thor, will be an intermediate-range ballistic missile with a range of 1,500 nautical miles.

Two of these missiles, the Atlas and the Thor, are now in the flight-test stage. Let's look at the industrial and test base which has been created and which has brought this program along so spectacularly.

AT Convair a vast plant area is already engaged in the production of Atlas airframes. Soon, however, Atlas airframe production will be centered at an entirely new Convair facility at San Diego, Calif. This complex will contribute greatly to the base of test and industrial facilities important for future expansion in space technology.

Convair's backyard facilities in the San Diego area include the Point Loma test complex used for a variety of tests on Atlas airframes, and the Sycamore Canyon test area which was grazing land for cattle when ground was broken in October 1955.

Sycamore Canyon is now a vast complex for the captive testing of complete Atlas missiles. A second captive test stand in this complex recently has been activated.

The captive testing of these full-scale Atlas flight-test missiles permits the Air Force to evaluate the performance of the integrated propulsion system and airframe on the ground. This illustrates an important point of our test philosophy—to get as many answers as we can before risking a costly missile.

Turning to the Thor program, a development production line was built by Douglas Aircraft Company within eighteen months after signing the Air Force contract which brought that company into the Air Force ballistic missile program. Douglas has the responsibility for manufacturing the Thor airframe, for assembling the integrated missile, and for following through with the Air Force on the flight test program.

At Sacramento, Calif., Douglas has built a major captive-test facility, with single and dual test stands and their support complexes. This new facility received its first Thor missile in July. Hot captive test firings of complete Thor IRBM's are performed here.

The Martin Company, developing the Titan, a two-stage ICBM, has constructed a ballistic missile development, test, and production facility near Denver, Colo.

The Titan design is more sophisticated than that of the Atlas and follows the Atlas by about a year in its development schedule.

Without tremendous propulsive power, of course, this ballistic missile program could not get off the ground. A significant facet of the ballistic missile program, therefore, is the development of the rocket engines.

THE Rocketdyne Division of North American Aviation, Inc., was set up in 1955 to produce large liquid rocket engines. By May of 1957, Rocketdyne was producing engines for the Atlas, the Thor, and the Jupiter.

A few miles from the Canoga Park plant is the Santa Susana Propulsion Field Laboratory where the large liquid-fueled rocket engines and their allied components undergo extensive static tests. This facility has nineteen major test stands; twelve will take engines of up to a million pounds' thrust.

In line with the Air Force policy of dispersal, Camp Crowder, Mo., was chosen as the site for a second North American production plant for large rocket engines.

THE principal propulsion contractor for the Titan is Aerojet-General Corporation at Sacramento, Calif., where an impressive new rocket engine manufacturing and test facility was built. An administration building, a liquid-oxygen manufacturing plant, a cold-flow laboratory, six test stand complexes, and auxiliary buildings have been constructed and large liquid rocket engines are coming off the assembly line on schedule for testing.

Besides the contractor facilities, a substantial program of construction was required at a number of existing Air Force installations. As an example, the Edwards Rocket Base at the Air Force Flight Test Center in California, an installation of some magnitude, is used for propulsion and complete systems testing of Atlas and Thor missiles.

The test stand here, capable of taking a million and a half pounds of thrust, is used to captive-test an Atlas missile for a full-duration run. We believe it to be the largest test stand of its kind.

The TM-76 Mace tactical guided missile with automatic "brain" was successfully tested recently (Air Force photo).

The largest area of military construction in the program located on Government property is at the Air Force Missile Test Center at Patrick Air Force Base, Fla.

At the near-by Air Force Cape Canaveral launching site there will be a total of eleven ICBM and IRBM launching pads with fully instrumented blockhouses, LOX facilities, guidance, telemetery and tracking centers, and an industrial area for contractor occupancy.

Launch complexes have been completed to support the Thor and Atlas flight-test programs. Additional launch complexes, just north of the Atlas area, are being constructed to support the Titan test-flight program.

As to the test range itself, it was planned by the Air Force in 1946. While many people thought that the Air Force was "way out in the blue" in establishing the requirement for this 5,500-mile test range, it turned out that we barely got it in time. Presently, the Army, Navy, and Air Force are engaged in missile test programs at this center.

Our planning started as early as it did because of the extensive range instrumentation program required and also because most of this territory belongs to other countries and had to be made available through international negotiation.

LET'S turn now to some of the technical aspects of the program. One of the most critical of all ballistic missile problems is that of the nose cone which must survive the extreme heat of reëntry. Solution of this problem is shared by General Electric Company, Avco, and Lockheed Aircraft Corporation. The Missile Systems Division of Lockheed has gathered valuable reëntry data through a series of scaled-down, high-speed reëntry test-vehicle flights.

The X-17, the fastest fully instrumented missile ever flown by the United States, has attained a speed over fourteen times that of sound. The nose-cone test data accumulated in the X-17 program substantiate theory and indicate that the reëntry problem is solved. Twenty-six Lockheed X-17 reëntry test vehicles were launched in this research program. Of these, nineteen successfully fulfilled the test requirements.

The Air Force ICBM takes off on a successful flight (Air Force photo).

This highly successful test program permitted the Air Force to simulate ICBM reëntry conditions early in the ballistic missile development program without expending the much more costly full-scale ICBM's.

The first Thor missile was loaded for air transport to Florida in mid-October 1956, within five days of the schedule estimated a year before. The missile was on the test stand one year after the contract was let.

In the Thor flight-test program, ten missiles had been launched by the end of 1957. Five of the last six Thor's were successfully launched and have amply justified the confidence we have in the Thor design.

The Thor is the 1,500 nautical-mile IRBM built by the Douglas Aircraft Company. The missile is not a special research vehicle. It is an operational configuration made up of parts produced with actual production tooling.

In other words, when this missile is perfected through additional flight tests, it will essentially be in production in the final configuration. No extensive program of production engineering to be followed by a separate flight-test program of the production model will be required.

The necessary ground-support equipment to employ this weapon system in the field has been designed and developed, and the program for training Air Force units has been started.

THE purpose of a flight-test program is to isolate weak points in the missile and component designs. Even a launching which appears to be a complete failure, such as the first Thor and Atlas launchings which traveled only a few thousand feet, yield important data essential to producing the final operational prototype. So far we have found no major or fundamental design errors in either the Atlas or Thor missiles.

All the major contractors in support of the Atlas program have constructed new facilities at Patrick. These include Convair, General Electric, North American Rocketdyne, the Burroughs Corporation, American Machine & Foundry Company, and other important members of our industry team.

To date, four Atlas missiles have been launched, and while the first two were only partially successful they provided important information for the design and reliability of the final military weapon. The third and fourth were complete successes.

THE ballistic missile program is our springboard into space. As we look to the future it is obvious that we must develop the capability of operating in space with both manned and unmanned vehicles. We must develop the capability of space control just as today we have the capability of air control, because from a military point of view there is no dividing line between air and space.

In other words, we must keep our deterrent force in phase with the state

of the art. Our thoughts, therefore, must be directed toward the prospects of such future space weapon systems.

The man comes back into the picture as we visualize space weapon systems based on projections of our ballistic missile capabilities.

From the standpoint of offense, the hypersonic manned bomber launched like a ballistic missile and boosted up to an initial speed of about 18,000 miles an hour at an altitude of several hundred thousand feet will be able to circumnavigate the globe and glide back to home base.

The next weapon system in this family might be the satellite, either manned or unmanned, which can keep the globe under continuous surveillance—in other words, orbiting reconnaissance or "police stations."

Finally, space vehicles operating free of earth and capable eventually of flights to the moon or other planets are possibilities.

We must also think of the weapons of defense. Already we have the problem of defense against ballistic missiles. Basic to the solution of this problem is the development of radars to detect and track these missiles at long ranges.

One of these is the Millstone Hill radar. The antenna is eighty-four feet in diameter and weighs ninety tons. It is typical of the large, high-power electronic equipment necessary to acquire the data for positioning the enemy missile in space and predicting its trajectory. This knowledge is necessary if the countermissile is to carry out its mission.

THE job of the countermissile is essentially one of flying up the predicted terminal portion of the trajectory of the enemy ballistic missile and intercepting it. The boost-glide concept, if employed by the enemy, will make this job more difficult.

The satellite intercept problem has some interesting facets. Can we accurately and reliably predict the position of an enemy satellite at a particular instant and launch a countersatellite to intercept it?

The pacing element of such a counterweapon will be the complex system of ground and airborne electronics automatically to ensure intercept and destruction. To get this capability most quickly, the man will come back into the picture to substitute for electronic complexity.

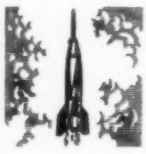
"We must develop the capability of space control just as today we have the capability of air control, because from the military point of view there is no dividing line between air and space . . . We must keep our deterrent force in phase with the state of the art."

How might such an interceptor operate? If behind the target and trying to pick up distance it will need power to increase speed. As it increases speed, however, its orbit altitude will increase or it may even escape.

There also is the problem of sighting the target. Perhaps infrared detectors may be the answer for this.

Then we must launch missiles to destroy. These missiles must be so directed in a depressed trajectory so that they will intercept the target and not escape into space before accomplishing their mission.

We have a lot to think about and a lot of basic work to do in making possible future Air Force operations in space.



Propulsion is a major area of effort to be exploited. Our military and civilian scientists and engineers are working in fields of high-energy fuels, solid propellants, ion propulsion, solar propulsion, and other exotic fields searching for the answers.

In recent months, considerable attention has been called to solid-propellant rockets and their benefits. The Navy Polaris IRBM is based on solid propellants, and the Army has been authorized to proceed on a 200-mile solid-propellant missile. The solid-propellant motor is not a new idea. The fact is that military interest in this area goes back many years.

Since 1950 the Air Force has pushed this avenue of rocket propulsion. In that year, efforts were begun in solid-propellant technology with primary emphasis on propellants and designs for aircraft jet-assist take-off units (Jatos). Since then, our solid-propellant budget has increased sixfold.

From this program came the first propellants using low-cost ammonium nitrate as an oxidizer. Also produced was the highest-thrust propellant rocket engine developed to date, first fired in 1957. High-performance propellants using certain special polymers as fuel binders also were tested.

Present emphasis in this program is on high performance and large motors. Within the next several months we anticipate that the largest solid-propellant motors ever made will be test-fired by Air Force contractors; furthermore, in the not-too-distant future these large engines will be surpassed severalfold.

The building blocks already available to us from our work in propulsion, electronics, materials, human factors, and aëromedicine, and the new knowledge to be gained in the years ahead may make space operations possible sooner than many of us anticipate.

The advances recorded by the over-all Air Force missile program in mobilizing manpower, materials, and facilities on such a vast scale within so short a time are the direct result of the unprecedented and coöperative integration of the national resources of science, government, and industry.

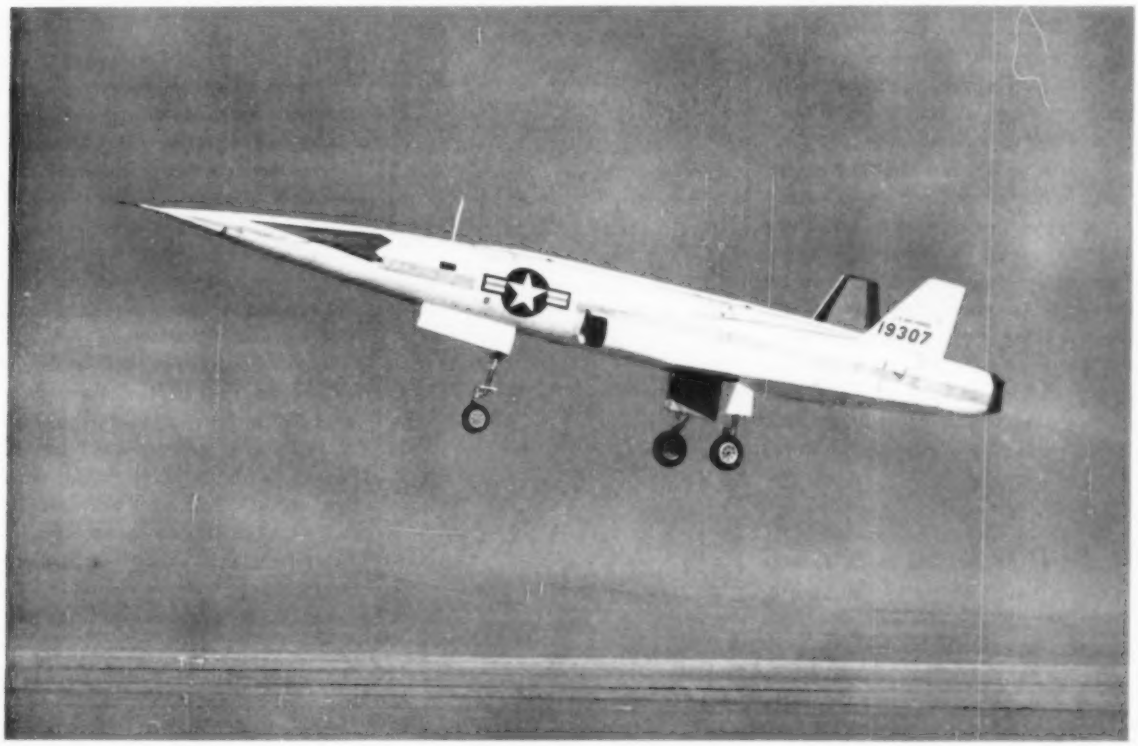
No service has invested as much money and effort in missile research and development and missile test facilities as has the Air Force. We have objectively and realistically approached the missile era. We have organized our research and development structure for missiles. We have encouraged and employed industry in missile work, and we have set up testing centers for long-range guided missiles.

We have carefully integrated our missile programs with consideration of all facets of our responsibilities for the national defense. We have definitely sought for and pushed into the missile field and we believe we have it firmly within our grasp.

Rather than bringing death to the flying Air Force, the guided missile, in combination with manned weapon systems in use today and planned for the future, will provide integrated and flexible air power of even greater strength in maintaining our national security.

In the Missile Arsenal

Regulus II, the Navy's surface-to-surface, supersonic, jet-powered guided missile, above, soars off its launcher under the impulse of its single booster rocket. It can be fired from submarines and surface ships. The Air Force's X-10 unmanned supersonic test missile, below, is shown about to touch down under control of its automatic landing system.



Ordnance Missile Command

The new organization headed by General Medaris will control and coördinate all the widespread missile activities of the Army

THE Commander of the new U. S. Army Ordnance Missile Command will report directly to the Chief of Ordnance. In executing his missions, the Commander, Ordnance Missile Command, will be able to call on all Ordnance resources, including other commands, arsenals, proving grounds, laboratories, depots, and districts for support in their specialized fields. The new command arrangement parallels that of the Ordnance Weapons Command, the Ordnance Tank-Automotive Command, and the Ordnance Ammunition Command.

Subordinate agencies include: the Army Rocket and Guided Missile Agency (formerly Redstone Arsenal), the Jet Propulsion Laboratory, the Army Ballistic Missile Agency, and White Sands Proving Ground.

The Army Ballistic Missile Agency will continue to be responsible for such weapons systems as Jupiter, Redstone, and the newly authorized Pershing. These longer-range weapons, once fired, receive no additional guidance from ground-control troop units but follow a "ballistic" path or trajectory similar to an artillery projectile. Any space projects assigned to the Army and boosted into orbit by Jupiter or Redstone systems also will be executed by the Army Ballistic Missile Agency.

The Army Rocket and Guided Missile Agency will be responsible for free rockets (Honest John) and for guided missiles such as the Dart antitank missile; Lacrosse, the highly accurate surface-to-surface guided missile; the Nike family of antiaircraft "guided" weapons systems; and the portions of the antimissile missile developments assigned by the Advanced Research Project Agency, Department of Defense. Also included is the Army's Hawk low-level antiaircraft system soon to become operational to protect ground troops and cities against hostile weapons coming in "on the deck."

The Jet Propulsion Laboratory is a Government-owned, contractor-operated, Class II installation under the cognizance of the Chief of Ordnance. The contractor is the California Institute of Technology. A pioneer in the guided-missile field since the early 1940's, the Jet Propulsion Laboratory has developed the Corporal missile system, is currently assigned responsibility for development of the Sergeant, and was responsible for the design of the Army-launched satellite, Explorer.

The White Sands Proving Ground provides integrated range facilities for flight testing of missiles under development by all three services, conducts laboratory tests of components of Army missile systems under development, and provides independent engineered testing of the completed Army missile systems prior to release to the intended user.

On March 31, 1958, the U. S. Army Ordnance Missile Command was established at Huntsville, Ala., under the command of Maj. Gen. John B. Medaris, who formerly headed the Army Ballistic Missile Agency there. Maj. Gen. H. N. Toftoy, former commanding general of Redstone Arsenal, is Deputy Commander of the new Missile Command.

Heads of the subordinate agencies under the new command are: Brig. Gen. John A. Barclay, Army Ballistic Missile Agency; Maj. Gen. W. E. Laidlaw, the integrated White Sands Proving Ground; Dr. William H. Pickering, Jet Propulsion Laboratory; and Brig. Gen. John G. Shinkle, Army Rocket and Guided Missile Agency, formerly known as Redstone Arsenal.

THE U. S. Army Ordnance Missile Command will combine these agencies in one command structure and to it will be assigned responsibility and delegated authority for the execution of the total Ordnance mission with respect to guided missiles. This assigned responsibility includes: design, development, procurement and production, and supply, distribution, and maintenance with respect to assigned matériel.

Contracts in this field will be placed, in accordance with customary Ordnance practices, through established local Ordnance procurement districts throughout the country. At the same time, the new command will continue to look to American science and industry for their invaluable contributions in developing Army weaponry.

The successful development of each of the Army's missiles and rockets is the result of highly integrated and coordinated teamwork among American scientific and industrial concerns and

the Army's arsenals. The successful launching of the Jupiter-C rockets carrying the Explorer satellites into orbit is further evidence that this team is meeting the challenges of the new technological age. While Army arsenals for generations have developed fine weapons, they have now regeared their organization and capabilities to the era of atomics, electronics, and supersonic rockets and missiles.

GENERAL Medaris, with his team of technicians and scientists under the direction of Dr. Wernher von Braun, developed the Jupiter IRBM at Huntsville, Ala., sent the Army's Jupiter-C nose cone test missile 3,300 miles over the Atlantic a year and a half ago, and placed the first U. S. satellite into a successful orbit.

Dr. von Braun was instrumental in developing the German V-2 at Peenemünde and is now leading the Army's ballistic missile development team at ABMA.

General Toftoy pioneered Army development and production of rockets and guided missiles. It was General Toftoy who brought Dr. von Braun and his team to the United States. Under his direction, antiaircraft weapons systems like the Nike, now defending our cities and industry throughout the country, came into being.

Dr. Pickering is the scientist behind the development of the solid-propellant Sergeant. A reduced version of the Sergeant motors gave the final propulsion impetus to the Army's Explorer. The satellite itself was assembled by the Jet Propulsion Laboratory which provided the radio transmitters and incorporated in the instrumentation payload experiments designed by the Jet Propulsion Laboratory, the State University of Iowa, and the Air Force Cambridge Research Center.

THE Army Rocket and Guided Missile Agency (formerly Redstone Arsenal, Huntsville, Ala.) is currently employing approximately 5,500 civilians and has over 900 military personnel assigned. The planned program for this agency for fiscal year 1958 will amount to approximately $706,000,000.

The Jet Propulsion Laboratory, located at Pasadena, Calif., is a Government-owned, contractor-operated installation. The contractor is the California Institute of Technology. This laboratory is currently employing over 2,000 civilians and has a yearly program of approximately $32,000,000.

The Army's new solid-propellant, surface-to-surface Sergeant guided missile starts a flight from White Sands Proving Ground where it was being tested.

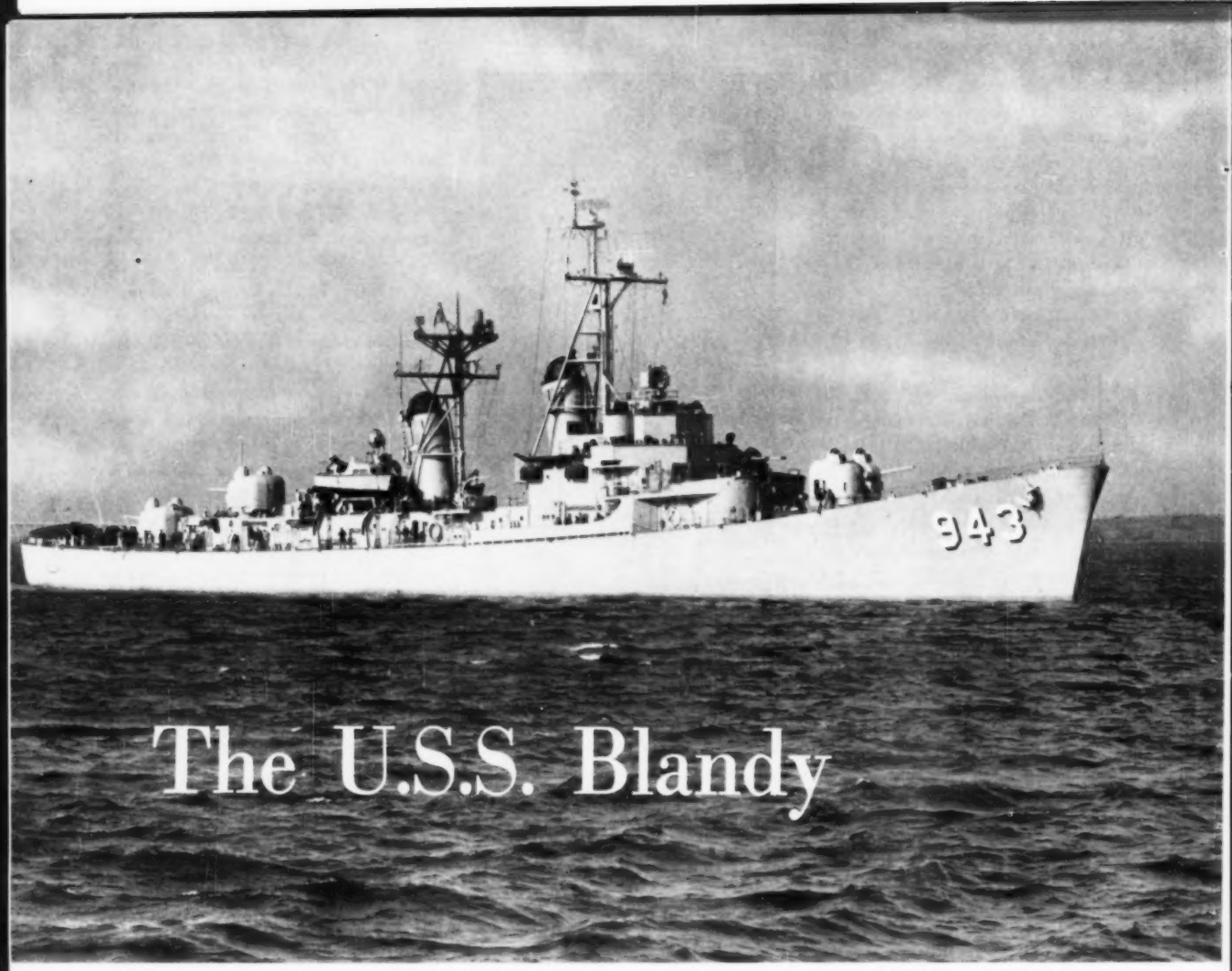
WHITE Sands Proving Ground, N. Mex., provides range facilities for flight testing of missiles under development by all three services. Laboratory tests of components of Army missile systems under development and independent engineering tests of the complete Army missile systems prior to release to the troops are conducted here. White Sands Proving Ground is currently employing approximately 3,500 civilians and has approximately 2,000 military personnel assigned.

The Army Ballistic Missile Agency has been operational for over two years. This agency developed the Redstone Missile System which becomes operational with Army units in the field this summer and the Jupiter Missile System, which was developed on a national priority. Jupiter will be operational with Air Force units by the end of this calendar year.

The Army Ballistic Missile Agency has just been assigned the responsibility for the development of the new Army ballistic missile, Pershing, a solid-propellant second-generation field-army missile about the same size as but of greatly increased range over Sergeant. Pershing will eventually replace Redstone in the field army.

The Army Ballistic Missile Agency was responsible for launching the first satellite, Explorer, using its proven components as a basis for this accomplishment. The Army Ballistic Missile Agency employs approximately 4,300 civilian employees and has approximately 625 military personnel assigned.

THE Army Ordnance Corps uses its civilian and military specialists, the scientists of colleges and universities and the special technical and engineering skills of industry as an integrated team. This team has worked together to produce the Army's family of guided missiles and rockets and will continue to function under the new command.



The U.S.S. Blandy

(Bethlehem Steel Company photo)

The memory of a splendid officer lives on in a fine fighting ship

Vice Adm. George F. Hussey, Jr.

AT the Naval Academy, the first formation of the new academic year is always a stirring event, for then the new midshipman officers take their posts and the plebes for the first time become a part of the Brigade. On that occasion, in the fall of 1912 as a plebe in the rear rank, I heard the voice of the new five-striper giving his first commands in what was then the highest midshipman office. There was no doubt that it was the voice of a man born—and trained—to command.

Within a few weeks I learned that he was also a leader, when as captain of the fencing team he took time out to give personal encouragement to a plebe on the fencing squad. From that period on I looked up to Spike Blandy.

Graduating Number One in the class of 1913, he joined the FLORIDA to begin a career which led him by the twin paths of ordnance—the material—and gunnery—its use—to the head of the Gunnery Section of Fleet Training and to Chief of the Bureau of Ordnance. Along that course I had the privilege of serving close aboard him in the fleet, and alongside when we were section chiefs in the Bureau.

Appointed Chief a few months before Pearl Harbor, his first act was to reorganize the Bureau of Ordnance so that it could handle the huge task of supplying armor, armament, and ammunition to the fleet as well as to our sister services and to our allies. In that task, so vast that it involved the obligation of over thirteen billion dollars, Admiral Blandy enunciated the principle that it is a misdemeanor to have too much, a crime to have too little.

Working closely with industry and organized science, he brought their combined efforts to the solution of many problems in naval ordnance, providing not merely new means of overmatching enemy devices but also bringing out new and superior weapons of our own. Notable among these was the VT fuze, for which no counter was found and which played so important a part in the defeat of both the Germans and the Japanese as well as contributing largely to the defeat of the buzz-bomb attacks on England.

I SERVED for fifteen months from the middle of 1942 as one of the division directors to whom Admiral Blandy delegated responsibility and commensurate authority, and, briefly, as his Assistant Chief. When an opportunity came near the end of 1943 for him to go to sea, I succeeded him and learned how well the Bureau would run under the momentum he had imparted.

As an amphibious commander Admiral Blandy played a distinguished rôle in the operations which carried the war to the very doors of Japan. His long experience in ordnance and gunnery came into play when he commanded the preinvasion assault forces which supplied the naval gunfire preparation before the landings on Iwo Jima and Okinawa and the support fire for the troops after they were ashore. He was present at the surrender of the Japanese aboard the MISSOURI in Tokyo Bay.

Within a few months he became a vice admiral and was assigned to command Joint Task Force One. Here again his organizing genius had full sway as he planned and conducted Operation Crossroads, the first test of atomic weapons against naval targets. When the results of those scientifically planned tests had been evaluated, he went to sea in the Atlantic and in February 1947 hoisted his 4-star flag as Commander in Chief, U. S. Atlantic Fleet.

His outstanding accomplishments brought him many honors and decorations from our own services and from our allies, all of which he wore with modest pride.

Whatever our relative positions, I found in Spike Blandy a friend who was always ready to discuss service problems—technical or policy—or, when occasion offered, to relax and enjoy the amenities and the lighter side of life. Never did I know him to trim his sails for personal advantage. Every idea he advanced, every decision he made, and every action he took was predicated on his sound judgment of the good of the service.

So much for the man whose name this ship bears. Now what of the ship herself? The Bureaus, her designers, her builders and suppliers have combined their talents, their skills, and their material resources until today we stand aboard a splendid example of a modern fighting ship. At their best they could produce only an inanimate object. In a few moments, building on months of careful preparation, her officers and crew will take the first formal steps in the long process of making her a living entity, a vital part of the fleet. Before them stretch many weeks, even months, of arduous work in which they will probe her capabilities and their own, learn her moods and how to cope with them, and become thoroughly attuned to the manipulation of her myriad pieces of complex equipment.

THAT equipment is vastly more complicated than any with which Admiral Blandy or I were shipmates, but it is the development of work begun in his regimes in the Bureau and the fleet. As her shakedown and the training of her officers progress and the ship, at their hands, finds herself, may they remember that they are applying modern tools to ancient problems involved in the control of the sea. Even in this day of guided missiles, space satellites, and all those modern wonders, control of the sea is vital to our country, and the men of the Navy have a vital part in securing and maintaining it.

A ship's name is the label by which she is known throughout the service. Our long-standing practice of naming destroyer-type ships for officers and men who have made heroic or outstanding contributions to the service and its traditions, seems sound. It brings to those who serve in a ship the inspiration deriving from the record of the individual whose name she bears. What is done with this ship will determine whether the name of Blandy once again will be one to conjure with in the Navy.

Commissioned at the Boston Naval Shipyard on November 26, 1957, the U.S.S. BLANDY *was named for the late Adm. W. H. P. Blandy, a distinguished naval officer and a leader in the affairs of the American Ordnance Association. The principal address at the commissioning ceremonies was delivered by Vice Adm. George F. Hussey, Jr., himself a distinguished officer, a former president of the A.O.A., and now managing director of the American Standards Association. Admiral Hussey's remarks are published here as a tribute to the memory of Admiral Blandy and as a salute to the ship which now bears his name.*

It was eminently fitting that Admiral Hussey was selected to give this address since he was closely associated with Admiral Blandy throughout much of his naval career. When Admiral Blandy was Chief of the Navy Bureau of Ordnance in World War II, Admiral Hussey served as director of the Planning and Production Division and then as Assistant Chief of the Bureau. In December 1943 he relieved Admiral Blandy as Chief of the Bureau.

Both admirals also served together as officers of the American Ordnance Association—Admiral Hussey as president of the New York Post from 1950 to 1954 and as president of the Association from 1955 to 1956. He has been a national director since 1954. Admiral Blandy was appointed a director of the Association in 1951 and served as vice-president from early 1954 until his untimely death later that year.

The Blandy Gold Medal, established in 1951 to commemorate Admiral Blandy's distinguished service to the Association, has been awarded to naval leaders who have been outstanding in ordnance progress and will be awarded this year to Admiral Hussey.

The Soviet Fleet

Red trawlers patrolling the surface of the sea and Red submarines cruising beneath may be able to separate us from our allies, but lack of carrier-based aircraft may limit Soviet naval effectiveness

William V. Kennedy

OUT of the fog covering the harbor of Reykjavik, Iceland, there emerged one winter day in 1954 a strange craft, indeed.

To all outward appearances the new arrival was a trawler, built on the same lines as the hundreds of her sisters that fish the North Atlantic. That she had been at sea for many weeks was apparent. But the fishing gear that was, supposedly, her purpose in life had never been broken out. Its condition and its manner of stowage were as though she had just put out from Bergen, or Aberdeen—or Murmansk.

To the fishermen of the North Atlantic, the trawler that wasn't a trawler at all confirmed what they had long suspected.

Scattered over the Norwegian Sea, the North Sea, the Denmark Strait, and the North Atlantic as far as the coast of Newfoundland is a swarm of Soviet trawlers supported by a half dozen or so "mother ships," which service the trawlers as a tender services destroyers or submarines.

MOST of the trawler fleet does, in fact, pay its own way as a fishing fleet. Its real significance, however, lies in its employment as a quiet, far-flung intelligence-collection service.

The trawler fleet serves, in addition, as an early-warning screen covering the Atlantic approaches to Northern and Central Russia, as an actual or potential means of refueling and resupplying Soviet submarines and surface raiders, and as a means of prepositioning small Soviet forces for attacks against isolated Allied garrisons in the Arctic and sub-Arctic.

Mr. Kennedy is former executive editor of the Pennsylvania Guardsman and is currently an officer of the 104th Armored Cavalry Regiment, Pennsylvania National Guard.

That this extensive capability could have been built, without fanfare and with the humblest of means, on the very doorstep of North America is indicative of the manner in which the Soviet Union has used all the resources at her disposal to create a formidable naval strength.

That strength, in the words of Adm. Jerauld Wright, NATO Supreme Allied Commander, Atlantic, serves but one purpose—"to separate the United States from its allies overseas."

The very fact, however, that the trawler fleet must accomplish by subterfuge what the Soviet Navy is unwilling or unable to do in the open betrays one of Soviet sea power's major weaknesses —it continued adherence to the "fortress fleet" concept of naval warfare.

Operating under the shadow of the army, the dominating power in the Soviet Ministry of Defense, the Soviet Navy, as was its predecessor, the Imperial Russian Navy, remains tied to the missions of defending the Soviet and satellite coastlines, interrupting the communications of the enemy, and supporting the operations of the army.

The mission, defined by Mahan as the epitome of naval operations, not only of denying the avenues of the sea to the enemy but of gaining the use of those avenues for one's own purposes, remains submerged, it appears, under the army's preoccupation with land warfare and the fascination of the Soviet leaders with bombers and guided missiles.

THE Soviet fleet has no aircraft carriers, nor are any known to be under construction. Its only capital ships are three battleships, two of World War I vintage, the third the 23,622-ton former GUILIO CESARE, taken from Italy at the end of World War II. One of the three, the old OKTYABRSKAYA REVOLUTSIA (October Revolution), heavily damaged in World War II, was reported in 1954 to be in use as a school ship.

Obsolete or obsolescent, the Soviet battleships are of use only in the shore-bombardment rôle—and that only where Soviet air power has supremacy.

In terms of cruiser and destroyer strength, however, the Soviet Navy presents an entirely different picture.

Of 27 cruisers, ranging from 8,000 to 17,000 tons, 11 are modern SVERDLOVS, fully the equal of anything in the hands of the West with the exception of the new guided-missile classes.

Teamed with the SVERDLOVS, and the older, but still potent KIROVS and TCHAPAYEVS are, according to the latest U. S. Navy estimate, "almost 100" large, fleet-type destroyers of the SKORYY and OTLICHNYY classes.

Fortunately for the West, these fine ships are hobbled by a naval philosophy that ties otherwise mobile and dangerous task forces to the tether of land-based aviation. With carriers, the SVERDLOVS, SKORYYS, and their sisters could present a more serious threat to Allied control of the sea than is presented by the Soviet submarine fleet.

Without carriers, the new cruiser and destroyer force is relegated to the furtive and steadily more unpromising rôle of the surface raider and to the rôle of extending coast-artillery and mine-laying capabilities a few miles further out to sea.

THE remainder of the Soviet surface fleet is composed of over 100 destroyers and escort vessels, older and somewhat smaller than the SKORYYS and OTLICHNYYS, an estimated 300 patrol vessels, 500 minecraft, and 250 auxiliaries.

Of approximately 1,250 surface vessels, 393, or almost 33 per cent are ships of foreign construction, bought, looted, or borrowed and never returned, from the United States, Britain, Germany, Japan, Italy, Estonia, and Finland.

While new surface construction has helped make the Soviet fleet the second largest in the world, the ability to concentrate and employ those surface forces and, to a lesser extent, the submarine force as well, is still largely at the sufferance of the United States, Britain, and their allies.

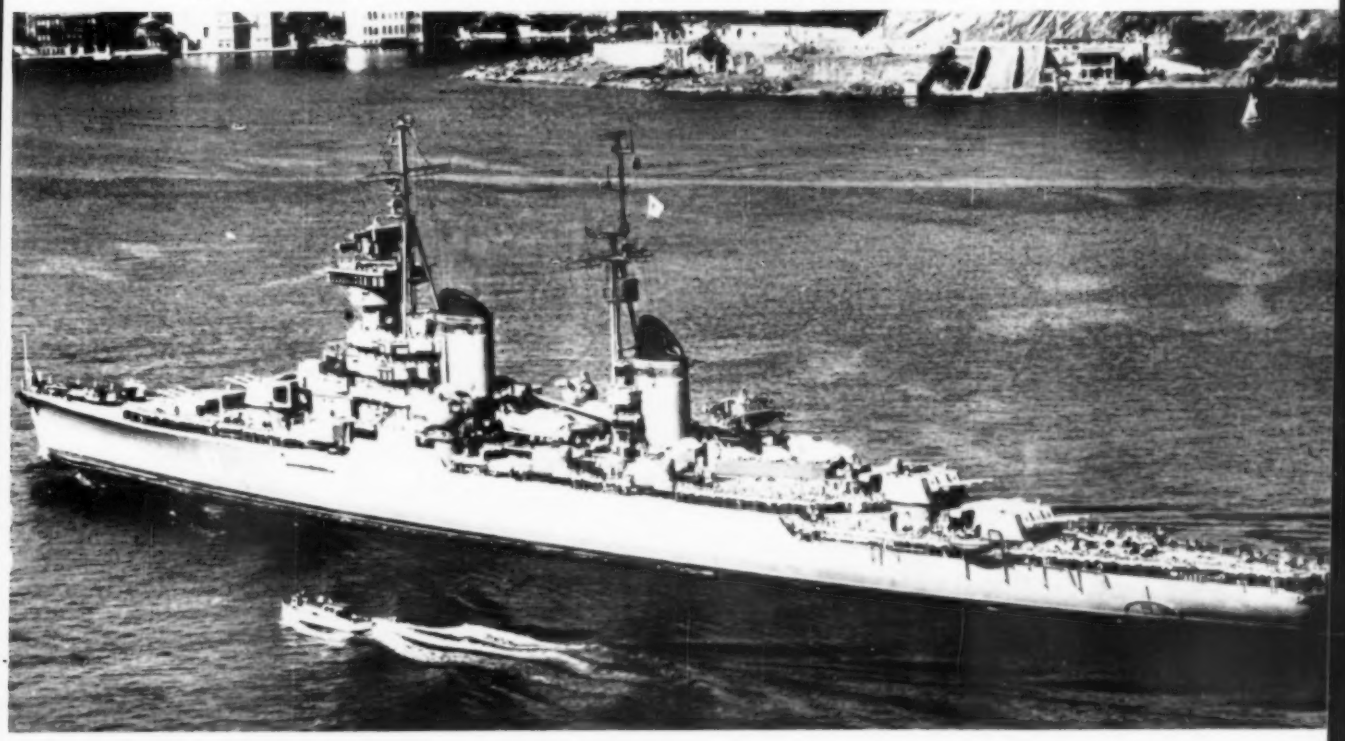
EXCEPT for the tenuous Northern Sea route through the Arctic from Archangel to Vladivostok, none of the four principal Soviet fleets—the Northern, or Arctic, the Baltic, the Black Sea, and the Pacific—is mutually supporting. All must pass one or more narrow, Allied-controlled waterways to move around the perimeter of Eurasia. Two of them must pass such bottlenecks even to get to the ocean. Canals within the Soviet Union permit the internal transfer of some light units, but not of the principal combat ships.

Turkey's hold on the Dardanelles, Britain's on Gibraltar, and that of the combined NATO fleet on the Skagerrak and the Kattegat leave the Soviets with but two sally ports on the open sea—the Murmansk-Archangel region in European Russia and the Petropavlovsk-Nikolaevsk-Vladivostok-Port Arthur coast in the Pacific. The Murmansk-Archangel area is the most dangerous in that it lies closest to the crucial North Atlantic sea lanes. The Pacific base region is limited by lack of fuel reserves and by the vulnerability of its communications.

The Soviets are reported to have over 450 submarines. Twenty of these are foreign boats of somewhat limited value; approximately one hundred are small, coastal types; another one hundred are medium-range attack boats. The total of long-range submarines is thought to be between 230 and 250.

THE newest and largest of the Soviet long-range submarines is the "W" class, based on advanced German types acquired at the end of World War II. These are rated at 2,000 tons and thought to have a range of 20,000 miles. They are credited by U. S. authorities with a 10-day station-keeping capability

Soviet SVERDLOV-class cruiser, a fast, well-armed ship of long endurance, the equal of anything similar in the West.



off the East coast of the United States.

In the light of this, Lieut. C. Huan of the French Naval General Staff, writing in the July 1957 issue of the U. S. Naval Institute *Proceedings,* estimates that with 250 long-range boats the Soviets could have 110 on patrol or in transit at any one time, with a larger force in operation at the opening of hostilities. This is already equal to the maximum German capability of World War II.

WHEN the 100 medium-range Soviet boats are considered, the Soviet capability far exceeds the German peak. The Soviets, however, lack the support of strong naval allies such as Germany had in Japan and Italy, allies that did much to dissipate the defensive strength of Germany's opponents.

The existing, operational Soviet submarine strength consists entirely of conventional boats. A report in December 1957 that the Soviets had atomic-powered submarines in service, some of them equipped with ballistic missiles carrying thermonuclear warheads, was rated as premature by the U. S. Navy.

Admiral Wright, however, points out that "the Soviets have the means of producing an atomic-powered submarine. They have ballistic missiles. Their 'marriage' is only a matter of time."

"Without carriers, the new Soviet cruiser and destroyer force is relegated to the rôle of surface raider."

The Soviet Naval Air Force consists of an impressive array of the most modern Soviet combat types, ranging from long-range jet bombers to helicopters. Lacking aircraft carriers, all are land-based. Their crews are trained in naval tactics with emphasis on foul-weather flying.

As with all land-based airpower, the support furnished by Soviet naval aviation is transitory, lasting only during the few minutes of "combat time" allowed by fuel reserves for operation over friendly or enemy units. As long as this remains true, and as long as even a portion of Western carrier strength remains in action, the Soviets will be unable to use the sea lanes for their own purposes, no matter how successful their submarine offensive.

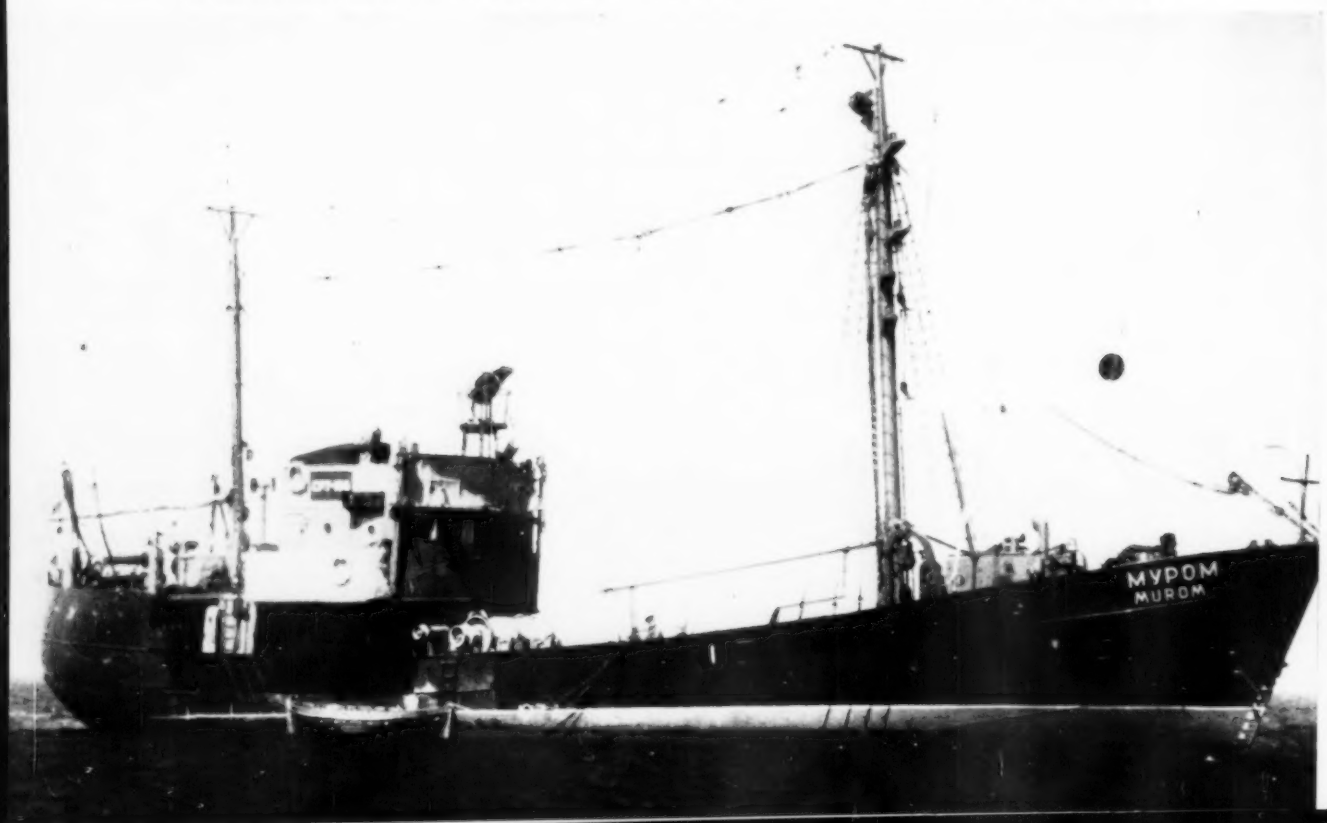
This portends a stalemate in which Soviet submarines may be able to separate us from our allies and from our sources of raw materials, but in which the Soviets may lack the ability to follow up their advantage by successful invasion of the North American continent. With neither side able either to achieve victory or to reorganize and rebuild a world torn by nuclear bombardment, the end result must be decline and chaos in both the Communist and Western camps.

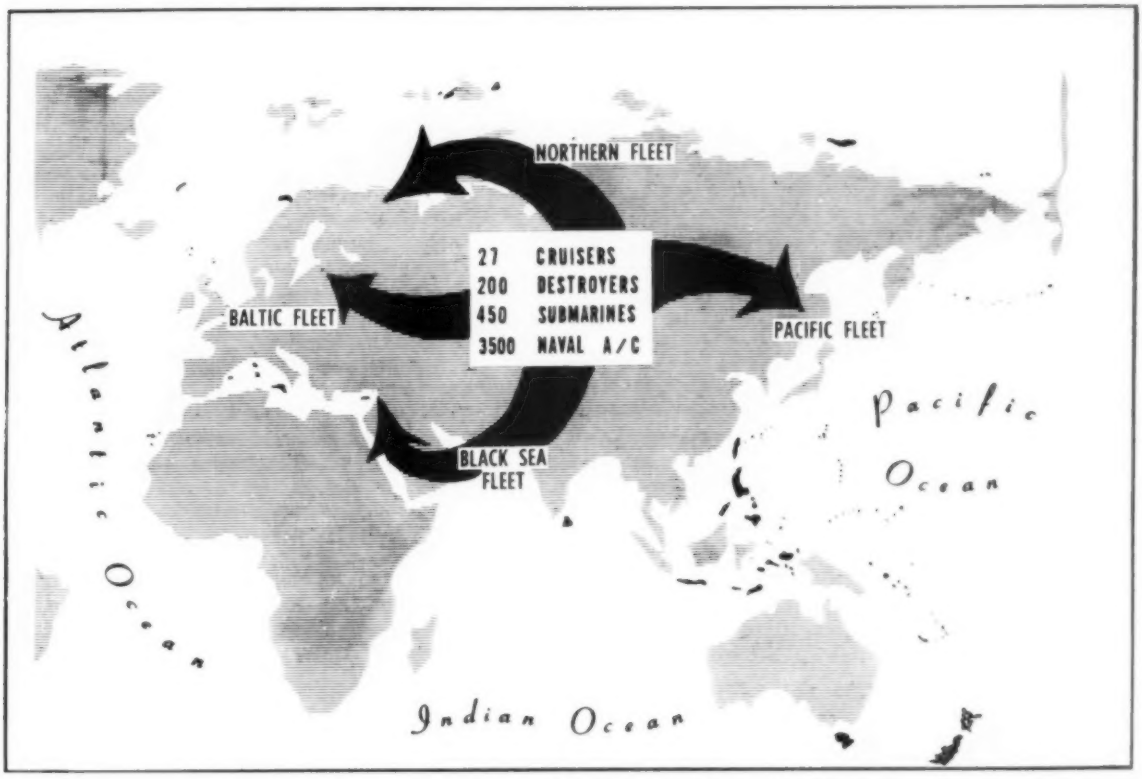
To avoid such a dilemma, the United States and its allies must be able to: (1) Defend port and base facilities against air and submarine-launched missile bombardment; (2) Maintain overseas communications; (3) Thrust aside the Soviet surface, air, and submarine forces standing in the way of amphibious operations against the Soviet Union itself.

It has been argued that the best defense against the Soviet submarine threat is the United States Strategic Air Command, attacking with missiles, or bombers, or both. Certainly, SAC and the carrier squadrons of the Navy possess the power, lacking in World War II, to destroy the major bases and shipyards supporting a submarine offensive. However, since a large proportion of the Soviet submarine fleet would be at sea, or dispersed among small coastal facilities, bombardment alone is not the answer.

IF we are to keep open the sea lanes on which the life of the Western world depends and on which eventual victory rests, the United States and Allied

The Soviet trawler, MUROM, one of a large number of which could become a serious menace to our Arctic stations.





Location of the main Soviet fleets and their total complement of naval vessels.

navies must possess the surface, air, and subsurface power to bottle up the Soviet fleet in the Baltic, Black Sea, and the Mediterranean, to "close the gates" of the northern approaches to the North Atlantic, to destroy those Soviet submarines and surface raiders that reach the open sea, and to handle such related threats as that posed by the Soviet North Atlantic-North Sea trawler fleet.

Adm. Arleigh Burke, Chief of Naval Operations, has stated that the United States and its allies can accomplish these objectives as long as the Soviet submarine force remains as it is at present.

WHAT happens when the Soviets acquire a force of atomic-powered submarines armed with nuclear missiles is something else again.

"There is no one weapon, no single tactic which of itself can provide an answer to the Soviet submarine menace, conventional or nuclear," Admiral Wright stated in an interview. "The solution lies, rather, in the coördinated employment of all our capabilities."

Are we doing enough to counter the Soviet naval threat?

To that, Admiral Wright replied: "We get along with what the people give us. The funds and resources provided will go only so far. If, as a nation, we have decided that we will only spend so much on the means to protect ourselves against the submarine threat, then we in the Navy must build the best defense we can with what we get."

And what if the resources provided are not adequate?

"If we wish to extend our air-defense boundaries as far away from our own borders as possible," Admiral Wright answered, "and we are doing that by maintaining overseas bases, alliances, and large forces of our own deployed overseas, then we must retain control of the seas. We simply cannot support such an effort in any other way.

"If we decide to give up control of the sea, then we must be prepared to write off, also, our bases overseas, our allies, and our own overseas forces. Our air-defense perimeter will then be moved to about our one-fathom line. We will have ensured that any full-scale war will be fought on and over the United States. I don't think we want that."

A land-bound naval philosophy, and a monolithic Soviet Ministry of Defense have denied to the Soviet fleet its rightful mission of attempting to gain control of the seas.

DESPITE this, the Soviet Navy has, or is acquiring, the ships and the skilled manpower with which to paralyze seaborne communications throughout the Western world. If it should succeed in accomplishing that mission any initial advantage we are able to achieve in the nuclear bombardment phase of a total war will be largely canceled out. We shall have lost the means of translating that advantage into final victory.

There are not likely to be any advance sputniks to awaken us to our danger in the race for naval supremacy. If, lacking such signs in the heavens, we choose to go on deactivating antisubmarine warfare units, blimp squadrons, and Naval Reserve facilities, we may awaken some day to find ourselves undone by a force as unspectacular as a sea-worn, ice-encrusted trawler or a gray submarine, slipping through the mists of the Atlantic.

Government of Space

The principles of international law which governed the conduct of nations for many years must be reëstablished on the earth and extended to regulate the actions of man as he explores the universe

Eugene E. Wilson

WHATEVER else the sputniks accomplished they performed one essential service by bringing to the fore the crucial problem of the government of space. That problem was first posed in 1903 when the Wrights unlocked the secrets of powered flight. As a problem of military strategy it flared into the open in 1925 as the Mitchell controversy. It erupted again in 1949 in the so-called "revolt of the admirals." Today it underlies the recent dissatisfaction of Army officers.

The fundamental schism which gives rise to such controversies has been swept under the rug as mere interservice bickering, but it runs far deeper than this. The time has now arrived when it must be brought into the open and resolved before the bar of public opinion to the end that security and tranquillity may return to a troubled world.

The crux of the problem was highlighted as far back as 1943 by none other than Orville Wright, one of the inventors of the airplane. On the occasion of the celebration of the fortieth anniversary of Kitty Hawk, Orville Wright issued a carefully worded public statement to the effect that, while he had no regret for the part he and his brother had played in that epochal event, he did deplore some of the uses to which the airplane was being put.

At that moment "Unconditional Surrender" was a popular slogan and the term "strategic" bombardment defined the revolutionary air doctrine adopted by Western Christian civilization. This doctrine revealed a complete right-about-face in the military posture which had characterized Western Christendom at the time of Kitty Hawk and for the century 1815-1914, known as *Pax Britannica*. That era of relative security and tranquillity had been governed by international law based on the principle of limitation as to the *use* of armed force.

In this atmosphere, the airplane afforded limitless possibilities as an argosy of peaceful commerce and industry. Then the rôle of military force was that of guaranteeing freedom of intercourse to those proceeding upon lawful occasions and of denying that freedom to such as defied the law. That principle of government was expressed in international law as the doctrine of Freedom of the Seas. The doctrine was expressed in two categories: The Laws of Peace and the Rules of War.

Mr. Wilson is former president of United Aircraft Corporation, East Hartford, Conn., and a pioneer leader in the aircraft industry of the United States. He is a graduate of the United States Naval Academy, Class of 1908, and author of the recent book, "Wings of the Dawn."

In World War II, however, under its slogan "Unconditional Surrender," the United States abandoned its historical legal posture following the Casablanca Conference in March 1943. Then the Allied chiefs of state adopted the British concept of strategic bombardment involving aërial attack of civilian populations to shatter civilian morale. This concept had its inception in the mind of a Fascist Italian general named Giulio Douhet, who began writing on the subject as far back as 1909.

FUNDAMENTALLY, it can be traced to Marx and Engels, who, a half-century earlier, had authored their concept of modern total war, a negation of international law.

Had aërial bombardment been undertaken in retaliation against an enemy breach of the law, it could have been justified under the general rule of the law. Unfortunately, such was not the case.

On January 9, 1943, just prior to the Casablanca Conference, Air Marshal Sir Arthur Tedder, R.A.F., declared in a public statement, "Today Britain alone of the embattled nations can look to a striking force in the air unshackled and untrammeled by parochialism and preconceived ideas."

Those "shackles" were, of course, the limitations which previously had been adopted by sovereign national states as an application of a higher law expressed in the Ten Commandments.

Now, Western Christian civilization owed its right to be called an advanced civilization solely to the self-imposed limitations expressed in international law. Its adoption of a posture of obliteration in place of liberation has not only threatened Western civilization with destruction but has put in jeopardy the survival of mankind.

Hence the crisis created by the advent of air power and the release of nuclear energy emphasizes the compelling necessity for a revival and revision of international law under the principle of limitation as to uses of force.

In approaching this difficult problem it is necessary to understand the interplay of societal forces in a civilization, as revealed by its history. The intelligible field of such a study of history is not that of any nation or national state, for no single nation has a history which is self-explanatory. The intelligible field of study of the rôles of air power and nuclear energy is a society containing a number of states, whose histories become intelligible only when a comprehensive view is taken of the societal forces acting throughout the civilization.

Societal forces fall into two broad categories—physical and spiritual. The first category includes those which are tangible and temporal. The second comprises those which are intangible and eternal. Societal forces included in the first category may be cataloged as military, economic, and technological. Those in the second category may be classified as political, cultural, and ideological.

THE interplay of these forces in a civilization is probably too complex to yield to scientific analysis. However, if history be viewed as a sort of laboratory report, and if the scientific method be applied as in the engineering profession, a trouble shooter should be able to discover the causes of a malfunctioning and even suggest changes of design to correct functional defects.

In the case of Western Christian civilization, wherein air power had its inception and nuclear energy was released, the very name suggests the possibility of a twin society. Such a blood relative is to be found in a twin society called "Eastern" or "Orthodox" Christendom. The schism between East and West is ideological. It involves two basic concepts: authoritarian and libertarian. The schism is as old as mankind, and it transcends all boundaries.

Western Christendom is predominantly libertarian in character, a trait which it acquired from Greece. It is affiliated with another predecessor, notably Rome. The history of Roman society documents an interlude of security and tranquillity called *Pax Romana*. Founded upon Roman law, and implemented primarily through land power, it flourished in the Mediterranean basin under the direction of the Roman Empire. *Pax Romana* was founded and maintained by applying societal forces to the control of communications and transportation throughout the empire.

Similarly *Pax Britannica* was founded upon international law, implemented primarily by maritime power based on Western Europe and deployed over the seven seas. The accepted titles of these enlightened eras, having been drawn from the names of their principal states of origin, tend to obscure the geophysical distinction which divides them. If called *Pax Terra Firma* and *Pax Nautica*, they suggest an extension of the principles which underlie them into a third dimension and the creation of a new era to be called *Pax Aëronautica*.

Viewed from the standpoint of control of communications, the analogy between the sea and air is close by virtue of the fact that, whereas the land is a normal habitat, the sea and air are both media of communications and transportation between occupied land masses. This geophysical difference dictates different functions for ground forces, as compared with seaborne and airborne forces, and so prescribes the mission of ground forces as that of occupation.

When, in April 1944, the Aircraft Industry Association was confronted with the task of suggesting a basis for an American air doctrine, it adopted the slogan "Air Power for Peace" and recommended a program which involved the establishment of an international law of the air patterned upon that of the sea.

Visualizing the United Nations as the medium for formulating such a body of law, it contemplated the United States, the founder and chief practitioner of air power, as the leading proponent of the government of space. That principle forms the cornerstone of President Eisenhower's proposal to outlaw the use of missiles in outer space.

THE problems involved in reëstablishing international law on land and sea, and extending the principle into the air space as well as outer space, are formidable. That it is not impossible of solution is evident from the fact that, twice before in history, statesmen have solved it. Real hope is to be found in the fact that at the meeting of the American Bar Association in London last summer the idea became the keynote of the session.

Perhaps the greatest obstacle to the extension of international law into outer space is the intransigence of Soviet Russia and the demonstrated unreliability of its leaders as regards international agreements. This obstacle hampers progress in so far as summit meetings are concerned and practically rules out treaties of any kind. However, where international law is concerned the objections are less valid.

Soviet leaders are insecure under internal pressures. Back in 1918, at a time when a military stalemate on land and sea prevented a decision in World War I, Woodrow Wilson toppled Kaiser Wilhelm by offering independence and self-determination to captive European ethnic minorities with his Fourteen Points. In so doing he reaffirmed the traditional American posture of liberation. His League of Nations was to be constituted as the medium for extending that principle throughout Western Christendom.

Unfortunately, the animosities aroused by Germany's breach of international law, as applied to submarines, created the vindictiveness made apparent in the Treaty of Versailles which sowed the seeds of World War II. During that war, Allied fear of a repetition in a German breach induced them to

strike first with "strategic" air power, an action which culminated in the A-bombing of Hiroshima and Nagasaki.

Subsequently the tragedy of "preemptive" warfare has become apparent with the advent of "absolute weapons" and their extension into outer space. This argues eloquently for a revival of international law and its extension into the third dimension.

International law was founded upon the precept of enlightened self-interest. By applying the principle of limitation as to *use*, drawn from the Ten Commandments which prescribed the limitations which individuals must impose upon their own uses of force in order to coexist in security and tranquillity under freedom, international law incorporated within itself a built-in limitation as to *size*. For, when military forces are restricted to attacks on military objectives, total war gives way to limited war and limitation of armaments

RESTRICTION of the use of military force to prescribed military objectives was inspired partly by humanitarian considerations now largely ignored. But such restraint was in no sense inconsistent with elementary strategic principle. On the contrary, it was implicit in that basic principle of creation, the conservation—or wise use—of energy in the universe, which is also expressed in the strategic principle of economy of forces.

Over the ages, scorched-earth strategy has always proved to be false economy, a principle that might be paraphrased in the question: What shall it profit a man though he conquer the world, if he first incinerate it?

International law was, therefore, not founded upon abstract theory. It was an application of profound wisdom, evolved out of the experience of the ages. Hence moral principle is no abstraction. It is a potent spiritual force against which no physical force can long survive. But like other societal forces it must be given direction if a civilization is to survive.

In seeking to give direction to the forces at work in Western Christian civilization, we may draw inspiration from the recent scientific demonstration that mass and energy are mutually interchangeable. This suggests an analogy in the mutual interconvertibility of all physical and spiritual forces, from the temporal and tangible to the eternal and intangible and vice-versa. This idea lends credence to the concept of eternal life and provides incentives to the creation of an ever-ascending social order.

Western Christian civilization is a living example of this process. In its present phase it had its inception in the sixteenth century, a fact revealed in the writings of Richard Hakluyt, a cartographer in the British Admiralty, a Christian minister, and the recognized evangelical prophet of *Pax Britannica*. In an epic poem introductory to his classic, "The Principle Navigations,"[3] Hakluyt drew his gospel from St. Paul's letter to the young church at Ephesus: ". . . endeavoring to keep the unity of spirit in the bond of peace."

It was this spirit of peace through sea power, and not conquest through that power, which caused the land powers of the Continent of Europe to join with Britain in the evolution of international law.

Until that law can be translated into space there can be no letup in the exertion of physical pressures. No valid limitation of armaments can be accomplished until international law has been reëstablished and valid evidence is forthcoming as to compliance with it by every major nation.

Such evidence can only be had through reasonable freedom of communication and transportation by land, sea, and air. Hence, the first requisite for security and tranquillity in the space age is agreement upon rules which exempt civilian populations from acts of barbarism, which rules are in truth a measure of the quality of any civilization.

IN practice such rules would deny the use of space to any weapon incapable of being pinpointed upon, and restricted to, such targets as the armed forces of the enemy. Acceptance of this principle would relegate "dirty absolute weapons" to the outlaw category which already includes poison gas and bacteriological warfare.

Enlightened self-interest dictates such action with any weapon which is hazardous to friend and foe alike or inimical to civilized society. And enlightened self-interest, not armed force which backs up the law, is the real force of any law.

THE initiative for a movement to revitalize international law should not come from the summit but rather from the grass roots, and the word must be passed directly to people all over the world. The will of the American people might be expressed in the language of the Preamble to their Constitution and the words of Abraham Lincoln along the following lines:

"We, the people of the United States of America, with malice toward none and with charity for all, with firmness in the right as God gives us to see the right, and in order to form a more perfect union, establish justice, insure tranquillity, provide for the common security, promote the general welfare, and secure the blessings of liberty for ourselves and posterity, do proclaim the following American objects:

"To promote the orderly expansion of communications and transportation under the governance of a body of just and equal law, founded upon the higher law of creation and evolution, to guarantee to the individual his inalienable right to freedom of movement while proceeding upon lawful occasions; and to deny that privilege to such as violate that law."

THE American object, as defined in the Constitution, offers no panacea for human ills. It seeks to establish and maintain a society founded upon just and equal law. For justice gives stability to a social order by giving everyone his due. Justice is the true foundation of society and a principle of humanity.

Broader freedom and surer justice, the prerequisites of an advanced civilization, are implicit in the advent of air power and the revelations of nuclear energy. The manifest destiny of the American people lies in the establishment and maintenance of a higher law to govern space.

The War of Words

The Soviets have far outclassed the U. S. with their linguistic firepower, but our "language warriors" are now in training to win a conflict where words and not bombs are the weapons employed

Dr. Jacob Ornstein

AT the midwestern University of Indiana a freshman listens intently to a question in Russian from his instructor. Hesitating a bit, he replies, "Da, ya govoryu po russki," which in plain English means "Yes, I speak Russian." "Ochen khorosho" the instructor nods approvingly, "Very good."

A linguistic reconnaissance detects sounds of Russian—new to American schools—elsewhere in the land. From a soundproof booth at Georgetown University a graduate student, assuming the gestures and manner of a United Nations interpreter, translates into the tongue of the Soviets a speech on the settlement of a border dispute.

An Annapolis midshipman rises to deliver a talk on his recent European cruise; from time to time an idiomatic error causes his listeners to smile slightly.

At West Point a cadet addresses his classmates, occasionally groping for the correct term as he explains the features of a Soviet aircraft.

Simulating a class at a Russian military academy, an officer at the Army Language School "disguised" in an imitation Soviet uniform, holds forth on a terrain problem.

Ranging from college freshmen to army colonels, these are the men who are fighting a little-known but important battle. Objective: mastery of the vitality strategic Russian language.

Every phrase and idiom of the tongue of the U.S.S.R. learned by these "language warriors" helps to strengthen the United States position in a conflict where words and not bombs are the weapons. Up to now the Soviets, by relentlessly increasing their linguistic firepower, have left us trailing far behind.

Dr. Ornstein is on the staff of the U. S. Department of Agriculture Graduate School, Washington, D. C. At present, he is on leave of absence as research associate at Harvard University, Cambridge, Mass. During World War II, he served in the Mediterranean with the Office of Strategic Services.

Our own lack of language specialists has been arousing national concern. Secretary of State John Foster Dulles pointed up the gravity of the situation when he stated, "The United States carries new responsibilities in many quarters of the globe and we are at a serious disadvantage because of the difficulty in finding persons who can deal with the foreign-language problem. Interpreters are no substitute."

General Maxwell Taylor, one of our foremost military leaders and a master of six languages, recently declared, "I am convinced that increasing our knowledge of foreign languages will add significantly to our national security."

World War II catapulted us into a position of world leadership for which we were linguistically unprepared. When Hitler attacked Poland, only about twenty of our universities were teaching Russian to a handful of students. Even today, almost twenty years later, this subject is available in only a small number of schools. The writer, in a survey recently completed by him and published by the State Department's External Research Staff, found that only 165 of America's 1,800 colleges offer Russian—to less than 5,000 learners! Other important Slavic and East European languages, such as Czech, Bulgarian, Serbo-Croatian, Hungarian, and Rumanian, are taught in only a few large schools.

THE Kremlin by contrast has gone all-out to equip Russian citizens with the ordnance of foreign idioms. No less than ten million Russians of all ages are busy studying English, not to mention a hundred other world languages. Young Russians generally begin languages at the age of 12, and one Moscow elementary school even imparts the three R's to eight-year-old tots exclusively in English.

If young Ivan attends the *polnaya srednyaya shkola,* or complete middle school, he is in for six solid years of foreign language study. Add three more to this if he goes on to a *vuz,* or highest educational institution.

No nation in the world is devoting

so much time and effort to the "war of words" as the U.S.S.R. A formidable network of special language institutes has been established in all the fifteen republics of that vast land. *New York Times* correspondent William Jorden recently described a visit to the Moscow State Institute of Foreign Languages, where 2,500 hand-picked young Russians receive a total 5-year linguistic immersion. Entering the Institute's projection room, he heard a second-year student supply the English narration for a film showing a visit to the Moscow Zoo. The youngster went on for twenty minutes, betraying only a slight accent and making a few minor errors of usage. Not many American graduate students even could have approached a similar performance in Russian.

UNFORTUNATELY, our chronic indifference to foreign languages has not been entirely outgrown. This has combined with the fear of the difficulty of Russian, about which so many misconceptions are current, to keep American youth away from its study in droves.

However, those pioneers who have braved the mysteries of this little-known tongue have been pleasantly surprised to find it easier than high-school Latin, and they have discovered that the strange-looking alphabet can be learned in about an hour and that the language is closely related to other European tongues (proved by such words as *tri* for three, *sestra* for sister, *mat* for mother, *voda* for water, and so on).

Be that as it may, the average college student has given Russian the cold shoulder, thus failing to help build a national reservoir of Slavic specialists. At the same time our civilian and military needs for Russian as a tool for interrogation, interpreting, research and analysis, and a score of other uses, are growing apace.

STYMIED by this lack of linguistic know-how, the Government and the armed forces have been forced to go into the language-teaching business on a scale never before known in American history. The largest program to be developed thus far under either civilian or military auspices is that of the Army Language School in Monterey, Calif. In this modern "Tower of Babel" buck privates rub elbows with field-grade officers in eleven months of all-out training, with just enough time allowed for a bit of physical exercise.

The school teaches 27 other Eastern and Western languages, but Russian is far in the lead with some 500 students and 150 instructors—a student-teacher ratio enjoyed by few learners anywhere. The corps of professors is recruited from the colorful ranks of former diplomats, political leaders, generals, journalists, and even includes Prince Nikita Romanoff, nephew of the late Nicholas II, last of the Czars.

The Russian-language march also has been joined by the service academies. At West Point fully one-fifth of the cadets have been exposed to two years of Russian by graduation time.

Not to be outdone by its military counterpart, the Naval Academy likewise has elaborated a practical program of Russian courses, which, incidentally, are open only to the cream of the students. Here, too, understanding and speaking are the order of the day, with stress on naval terminology and etiquette.

Dangerously lacking language-trained personnel to man its far-flung outposts, the State Department ten years ago set up the Foreign Service Institute. Its Language School, staffed by crack scientific linguists, offers courses in Russian and the major Slavic tongues.

Turning to academic institutions, there are encouraging developments all along the linguistic front. Great universities, such as Harvard, Yale, Columbia, Indiana, Princeton, California, Washington, Cornell, and Fordham, have built up hard-hitting programs which instruct American youth not only in the language but also in the background of the Soviets. Smaller schools such as Haverford, Colgate, Smith, and Vassar also have added excellent facilities.

In the Nation's capitol, the Georgetown University Institute of Languages and Linguistics has made an outstanding contribution to the language effort. This unique center has trained hundreds of civilian and military officers bound for overseas duty in some forty foreign tongues. Modern teaching methods and the most advanced electronic equipment lend real impact to Georgetown instruction.

All these programs add up to a respectable beginning in the preparation of Russian linguists, particularly in the fields of military affairs and international relations. However, one sector of the linguistic front—that of scientific Russian—is still woefully neglected. When so much is being written about the possibility of a Soviet technological "break-through," we can hardly remain indifferent to the inability of our scientists to read Russian.

The Soviet man of science, by the time he receives his full training, has been exposed to about ten years of language study, with stiff tests to pass in several tongues, particularly English. By painful contrast, only a handful of American scientists can follow Soviet research writings in the original. Consequently, they must depend on translations or abstracts. This results in a dangerous time lag and leaves thousands of articles and books, shedding light on technological developments in the land of the hammer and sickle, to gather dust on library shelves.

IT is obviously high time that we take stock of the Nation's civilian and military needs for Russian as well as other strategic languages. Present programs are definitely insufficient for our long-term requirements.

Little can be done, however, until both school administrators and students become more fully aware of Russian and other East European languages vital to the national interest. This could be done by a systematic information campaign, sponsored jointly by Government agencies and educational organizations, spelling out our needs and exploding the myth that Russian is so difficult that only geniuses can learn it.

In the struggle for the "minds of men" America cannot afford to remain tongue-tied on the international front. Although at present badly outdistanced by the U.S.S.R. in the "war of words," there is still time to step up our teaching not only of Russian but also of the languages of her satellites.

AMERICAN ARMAMENT, V

Fighting Ships

OF THE UNITED STATES NAVY

An outline of the operational vessels employed in combat by the United States Navy, designed by engineers and scientists of the naval service, educational institutions and industrial organizations and produced by American industry for the national defense

8

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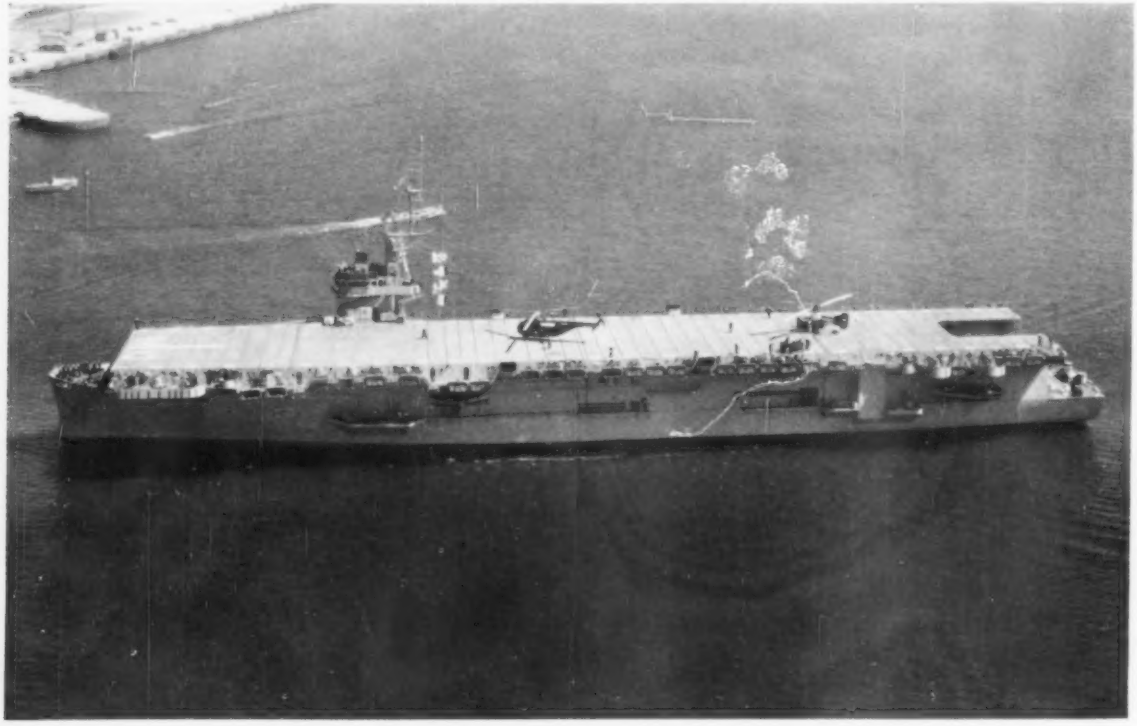
ORDNANCE

Bimonthly Journal of the American Ordnance Association
Washington 6, D. C.

Modern Aircraft Carriers

The U.S.S. FORRESTAL (CVA-59), above, is the first of a class of 6 modern 60,000-ton attack carriers. Length 990 feet, beam 129 feet, flight deck 250 feet, speed 33 knots. She has an angled landing deck, steam catapults, and enclosed bow structure. She carries 90 to 100 fighters and attack bombers and eight 5"/54 dual-purpose guns. The U.S.S. THETIS BAY (CVHA-1), below, is an escort carrier converted for trial as a Marine Corps helicopter assault carrier. Armament: eight 40-mm. and twenty-four 20-mm. guns.



Guided Missile Ships

The 2,400-ton U.S.S. GYATT (DDG-1), above, is our first guided-missile destroyer converted from the GEARING class. Length 390 feet, beam 40 feet, speed 35 knots. Armament: one Terrier missile launcher, two 5"/38 twin mounts forward, two 3"/50 twin mounts, two Hedgehog launchers. Below is the 13,600-ton U.S.S. BOSTON (CLG-1) guided-missile cruiser. Length 673 feet, beam 71 feet, speed 34 knots. Armament: two Terrier launchers, two 8"/55 triple mounts, five 5"/38 twin mounts, six 3"/50 twin mounts.

Guided Missile and Nuclear Powered Submersibles

The 1,525-ton U.S.S. TUNNY (SS-282), above, is a converted fleet submarine fitted with housing and launcher to handle Regulus I surface-to-surface missile. Length 311 feet, beam 27 feet, surface speed 21 knots, submerged speed up to 10 knots. The U.S.S. SKATE (SSN-578), below, is the third nuclear-powered submarine commissioned, and holds the transatlantic underwater crossing record. Displacement 2,700 tons, length 265 feet, beam 25 feet, speed 23 knots. Probably six 21-inch torpedo tubes.

New Submarine Developments

The U.S.S. ALBACORE (AGSS-569), above, is the prototype of a revolutionary "whale-shaped" hull design that concentrates on maximum underwater efficiency. From this test vessel the Navy has developed the SKIPJACK, a nuclear fleet submarine of 2,850 tons to be followed by a 3,000-ton class of 6 SSN's now building. Below is an artist's conception of a fleet ballistic missile submarine SSG(N). Authorized in the fiscal 1958 supplementary appropriation, it will launch Polaris missiles without surfacing.

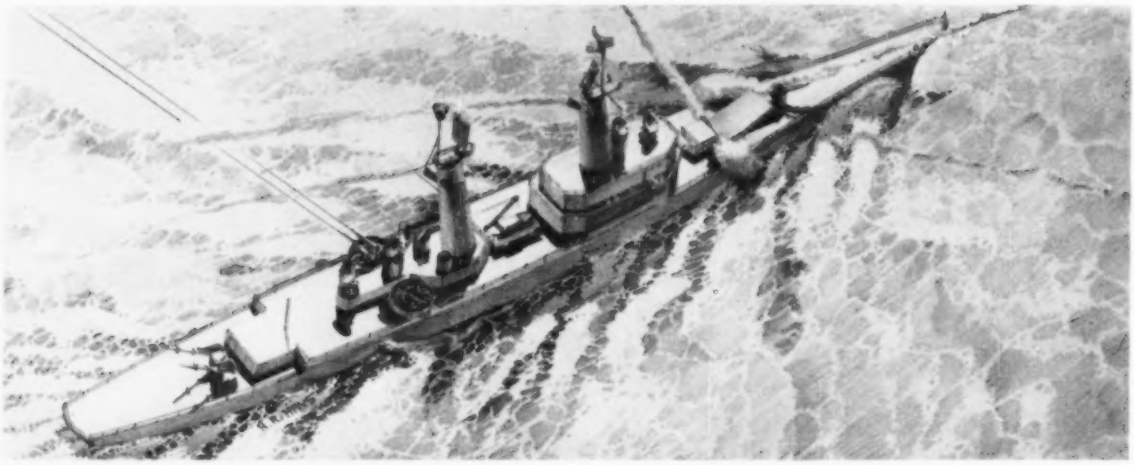
Heavy Cruiser and Command Ship

The U.S.S. NEWPORT NEWS (CA-148), above, is one of the last three postwar heavy cruisers. Displacement 17,000 tons, length 756 feet, beam 75 feet, speed 35 knots. Armament: three 8″/55 triple turrets, six 5″/38 twin mounts, twelve 3″/50 twin mounts. The 17,000-ton U.S.S. NORTHAMPTON (CLC-1), tactical command ship, below, is the only one of its class. Length 676 feet, beam 71 feet, speed 33 knots. Armament: four 5″/54 single mounts, four 3″/70 twin mounts. Carries tons of communication equipment.

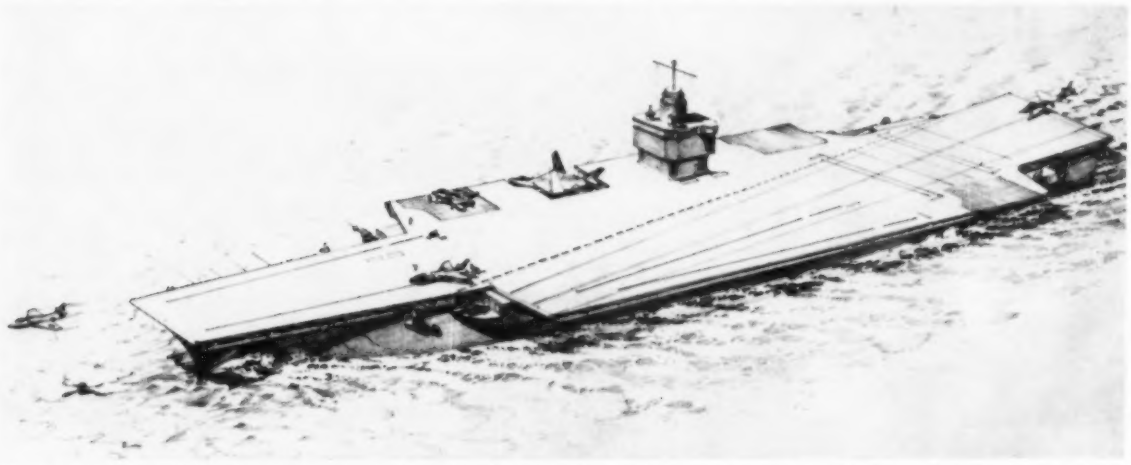
Modern Destroyers

The U.S.S. MITSCHER (DL2), above, is one of four in this frigate class. Displacement 3,675 tons, length 493 feet, beam 49 feet, speed 35 knots. Armament: two 5"/54 single mounts, two 3"/70 twin mounts, two Weapon-A directors and launchers, four torpedo tubes, one depth-charge track. The 1,450-ton U.S.S. DEALY (DE-1006), below, is one of a new postwar class. Length 314 feet, beam 37 feet, speed 25 knots. Armed with two 3"/50 twin mounts, one Weapon-A launcher, depth charges and torpedo tubes.

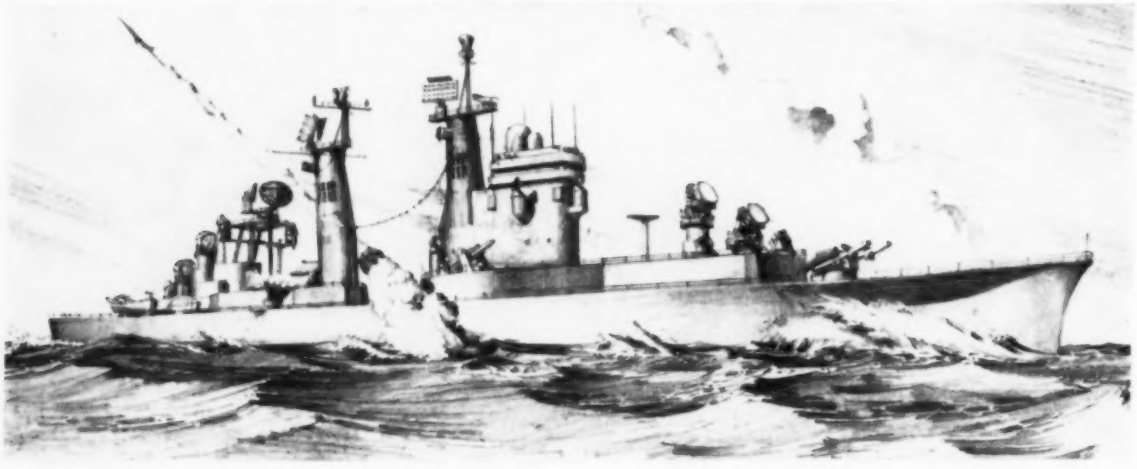
New Seapower for Tomorrow



Above is an artist's conception of a guided-missile frigate (DLG)—a follow-up on MITSCHER class. In addition to missile launchers fore and aft (Terrier or Tartar missiles) it will carry two 3-inch twin mounts and antisubmarine warfare weapon launchers. Twelve of this class are authorized. The next class will be nuclear-powered which will give these vessels unlimited range.



Above, drawing of the nuclear-powered attack carrier (CVAN-65). Preliminary figures list: 85,000 tons' displacement, length 1,088 feet, beam 133 feet, speed 35 knots. Armament: four guided-missile batteries, one for each quadrant. Below, artist's conception of a current guided-missile cruiser conversion project. Main battery: Talos missiles, secondary battery Tartar missiles.



Advice to a Young Man

At this time when the problems of technical education for the youth of America are in the forefront of popular discussion, these words of wisdom are as timely as when they were first written ten years ago

E. B. Gallaher

MY dear Robert—You ask me to lay down for you a formula for success in life—a difficult task, indeed, but I will try my best to give you some of the basic virtues on which a successful life must be built.

I will attempt to give you a long-range program—a program for your life's work to be accomplished over the years, not a program for immediate success.

In the first place, you must define what is meant by success before you can plan to achieve it. You must have a definite objective.

Do you wish to acquire great riches? Do you aspire to become a leader in industry? Do you wish to acquire a reputation as a scientist or an engineer? Or, possibly, you may have no ambition to become great and are looking forward to a quiet, normal, useful life which you can develop to the maximum of your mental and physical ability.

Success means the accomplishment of a definite objective.

One thing is certain: we all can't be great leaders, great scientists, nor possess great riches. To achieve any of these we ourselves must be outstanding, possess a combination of virtues, and have more than our fair share of luck. We must, therefore, look at things in a realistic manner, for we are living in a realistic world.

You are fortunate to be a student in one of our best engineering colleges, which immediately gives you an edge over those less fortunate. But you should know just what this engineering course can and cannot do for you, as many fall into the fatal error of believing that when they graduate they are fitted for immediate success.

All your college course can do for you is to coördinate your process of thinking and analysis. You are taught a little of a great many subjects, but it is not intended that when you graduate you will be skilled in any or all of them. The purpose is to give you a bird's-eye view of the various subjects which you have elected to study; to teach you certain basic principles; to show you where to obtain specific information when you may need it and then how to use it.

The college course also endeavors to build character and to instill in you the ethics of your chosen profession—in your case, mechanical engineering.

When you graduate you will be filled with theories and formulae, but you will have no practical experience either in your profession or in industrial life.

YOUR diploma is not a guarantee that you will be a success in the world or even in your profession. It simply means that you have served a sort of technical apprenticeship and are now prepared to enter upon your life's work. Your advanced training, therefore, must be obtained in industry, whether it be in engineering, chemistry, electricity, or in business administration.

Get this clearly in your mind and you

This letter was first published by the American Ordnance Association ten years ago—February 1948. So much public attention is focused today on the shortcomings and needs of our educational structure in the United States that its message is most timely now. It is republished here with the thought that it may help to crystallize thinking, particularly as it relates to the attitudes and disciplines which underlie all successful education.

The efforts of the American Ordnance Association for the advancement of armament preparedness through scientific education are related to the basic approach described by Mr. Gallaher.

When published ten years ago, this letter was in phenomenal demand. It is estimated that more than a million copies were printed. The author, the late Edward B. Gallaher, was a leading industrialist of the United States, a member and medalist of the Ordnance Association, and president of Clover Manufacturing Company, Norwalk, Conn. His forthright logic, clear expression, and sound conclusions presented here are a tribute to his leadership.

will have made the first great forward step for future development.

YOU should realize that you will be working in a country where 70 per cent of the entire population have intellects of children 14 years and under when they reach maturity—people who can do little thinking and planning for themselves. There are 16 per cent who have the normal intelligence of a person of mature age, 9½ per cent who have superior intellect, and only 4½ per cent who have very superior intelligence.

We can immediately state that the 70 per cent, having low intellect, must be provided for or guided by the 30 per cent who have normal to highly superior intellect. This is exactly what is taking place throughout the country.

You have succeeded in entering college, and the expectation is that you will graduate. This would indicate that your intelligence will be found at some level within the 30 per cent group.

There are thousands of other boys, however, who have not had the advantage of a college course. Among them there are many who rank high in intelligence and who have acquired great knowledge. You should not be surprised, therefore, to find many noncollege men working their way up to the top over college-bred men who may lack one or more of the essential qualifications for success.

Success will depend on a number of things: your intelligence, the amount of general and worldly knowledge you have acquired and knowledge of your particular work, tireless effort and your ambition to progress, your moral honesty, your ability to work with others as a team, your ability to raise and lower your own level to the level of intelligence of those with whom you must work and to do this so simply and easily that it becomes unnoticed.

YOU should realize that knowledge and intelligence are two separate and distinct attributes. You must possess both to succeed in a big way.

But even higher intelligence and great knowledge are not sufficient if you wish to direct or manage other people.

You must train yourself to make decisions quickly after you have the facts. You must not temporize, as this is fatal in an executive.

You may obtain an engineering degree, but this does not mean that you will follow engineering all your life. There are thousands of top executives in our great industries who were trained as engineers; now they are managing or merchandising. Their college course, however, has been just as as useful to them in their present work as it would have been if they had remained in engineering.

As you progress in life you may find you are better suited and more interested in work other than engineering.

Don't be afraid to change jobs often if the work you are doing fails to absorb your thoughts and energy completely. But do all your changing if possible before you are thirty. By that time you really should have found the kind of work you are most interested in, work to which you can devote your best effort and be happy. If you change jobs often after you are thirty you may be looked upon as a rolling stone, and no one will have confidence in you.

PUT off marriage until you have found yourself. Have a good job where you can earn enough to support a family—a job where you are positive that you are able to give full value to your employer with the reasonable certainty that you will be able to remain employed during slack periods as well as during booms.

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The greatest danger to the stability of your job is that you may be overpaid and will be one of the first to be dropped when signs of a depression appear or business falls off.

Again, may I suggest that a boy leaving school and rushing into marriage fails to realize that when he has reached thirty, has obtained a firm position in the world, has acquired the friendship of progressive and prosperous associates, he will, in many cases, be attracted by an entirely different sort of girl than when he was twenty.

A wife must be capable of developing with her husband. She can either help or ruin his career. What she lacks will have to be made up through greater ability and effort on his part. Sometimes this proves impossible. The lives of many capable men have been ruined by an unfortunate marriage.

As a single man you can move about to any part of the country where an opportunity is presented; take almost any kind of a job if the prospects seem good, regardless of the salary offered. If you are married you cannot always do this—you must stay put, and you must earn enough to support your family regardless. You cannot, therefore, take normal and reasonable chances which might be to your advantage.

HAD you asked me the same question twenty years ago, I would have stressed the importance of saving every dollar possible to build up a fund, to be employed first for the education of children, then to provide for your family in old age.

Saving is still important—very important—whether it be in the form of a savings account, insurance, a home of your own, or in sound securities.

But conditions today are not the same as they were twenty years ago.

In those days we were all free to do as we pleased. If we were intelligent, hard working, and thrifty, we could rapidly acquire enough knowledge to go into business for ourselves, keep

practically all our earnings to reinvest in our enterprise, gradually build up an estate for our family, and provide amply for the future.

Under present conditions it is virtually impossible to build up an estate through savings and careful investment which will suffice to provide for our family when we are gone or for our old age. We must, therefore, change our plans accordingly.

Assuming that you are a normal, intelligent, hard-working man with a desire to get ahead in the world, your best chance is to become associated with a thoroughly sound enterprise which produces something that has consumer acceptance and national distribution. Such a concern usually has some form of retirement compensation which is paid to employees after they reach the retirement age. There are many such concerns in various kinds of industry, so it should not be difficult to select some industry in which you could become really interested; then associate yourself with one of the companies within that industry.

A permanent job with the right company is today a better guarantee for your future than anything else under our present semisocialistic government.

A permanent job, however, depends on several conditions. The company must be recognized as a permanent unit in our national economy. You must occupy a position which you can really fill and give full value received for the amount you are paid; otherwise your job is not secure. Then you must constantly prepare yourself to step up to a higher position when it becomes available, studying the relationship of your job to all jobs about you.

In seeking a job, don't make the usual mistake of placing a value on your ability. The main thing is to get the right job with the right concern. The amount they offer you to start means nothing, as you may be certain that your various virtues and your ability, as well as your shortcomings, will be carefully appraised by your superiors, and your compensation will be quickly adjusted to them.

If I could only impress upon you the fact that really competent, energetic men of high intelligence are about the scarcest things found in every concern, you would quickly realize that management will do everything humanly possible to hold such men in their organizations, especially if they possess executive ability and are scientifically trained, for such men make better top executives than those who advance through other branches in industry.

IF you aspire to management and have the quality of leadership you should devote much of your time to the study of economics, for no one can successfully manage and promote an enterprise without a thorough knowledge of this subject, which deals not alone with problems of production but also with those of distribution and finance. We can often produce something which the public wants, but if we lack the knowledge of how to finance and distribute it, we are doomed to failure. Management at the top level has to supervise both production and distribution.

Breadth of knowledge is most important to qualify for top management. You should become acquainted with the manner in which all the many and varied elements in industry fit together to form a working unit.

To earn money legitimately you must produce something others are willing to buy. This is just as true in the case of a person who works with his head as it is for one who works with his hands. Quality and volume of production determine the wage.

If you are not appreciated by your employer as much as you feel you should be, go off where you can be alone and frankly check up yourself. There is some reason why you are not getting along. What is it?

Are you mentally capable of advancement? Is your knowledge both broad and detailed? Do you work well with others? Are you morally honest? Are you able to assume authority and make decisions? Are you sincere? Do you love your work?

In short, you must possess a combination of virtues to reach the top or, in fact, to reach any job on the way up. If you lack one or more of them your advancement will be checked at some point where these special virtues are required.

Never forget that though you may be highly intelligent, may be highly educated, and may have accumulated a great store of knowledge, all these valuable virtues will not assure your suc-

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cess in the world unless you are able to transmit them to others in language they understand and make people work with you happily. You must remain very human no matter how high you get. All big men are invariably very human.

As far as possible, do your own independent thinking. Read copiously and talk with others on any and all subjects, then do your own deciding. It is dangerous to set up some one in your mind as an oracle, as he may lead you far afield in moments of critical decisions. Independence of thought is a great asset to everyone.

You will need recreation of some kind to obtain a change of thought, but let it be of a character where you can dip in and out at will. Never allow your recreation to become a business with you, otherwise you will become a slave to it.

If you must drink, drink like a gentleman. Only a fool allows himself to become intoxicated. Many a brilliant career has been ruined through overindulgence.

BE friendly with everyone but choose your personal friends with care, for friends can exert a great influence on your future success or failure.

Your close friends should be of your own mental level or of a higher level; never of an inferior level. Select those who are intelligent, ambitious, anxious to succeed, frank and reliable—men and women who want to lead, not follow; people who are a success.

During your younger years always have a number of friends who are a few years older than you, those somewhat more advanced in position or having more responsibility.

After you pass fifty, make as many friends as possible among younger, aggressive men who have become successful—men who are doing things; because, as we grow old, we are more than apt to slow down, take things easy, and especially is this so if we have become prosperous. We therefore need young active men about us to keep our views in line with current thought. Keep your old friends, of course, but remember that old companions, without ambition, for an old man, will quickly bring his business career to an end.

Steer clear of all those who think or talk of socialism or communism. There are many of this kind all about us. Their purpose is to wreck our free American institutions. Your mere association with subversive characters could easily wreck your life.

Do not be overbearing in your conversation with others; you may have your say all right, but you will have learned nothing, as your listeners will keep quiet. Following this to the end point you might even gain the reputation of being a know-it-all and thus cut yourself off from much important knowledge.

Help those around you all you can. Every bit of help you give others will come back to you tenfold. You must have a sense of responsibility to your fellow man as well as for your own well-being.

Don't fail to show your appreciation for favors and little courtesies given you—it pays dividends. It's so easy to take things for granted, which always offends.

As suggested, you will find your level sooner or later, and when you reach this level your progress upward will stop. *Your aim should be to keep yourself mentally and physically fit and in trim so as to go as far as you possibly can.*

I STATED at the outset that I was attempting to give you a long range program. But even if my suggestions were perfect and you were to follow them completely you still may be certain that you will have lots of perplexing problems and lots of grief on your life's journey.

The reason for this is that you are bound to make errors; also that you will be dealing with hundreds of human beings, each having his own personal equation, each having a different mental level—some being honest and honorable, some tricky or dishonest. So the best-laid plans often will be thrown out of gear through no fault of your own.

You will have personal periods of prosperity as well as periods of depression—sometimes real trouble. But you must never lose your determination to surmount all difficulties. Never let them get you down.

Keep out of debt if possible. If you must borrow, let it be from a bank, not from an individual, for we are apt to be careless in repaying individual loans, resulting in bad blood and often enmity.

If you should fail in some undertaking, go at it again with renewed vigor. Ultimately you are bound to succeed. I know, because, during the sixty years in which I have been earning my living, I have had periods of great prosperity and periods when I went broke. If I had "thrown in the sponge" at such times I would probably be on relief today with a wrecked life behind me.

Every man at the top today has had his ups and downs but has refused to be licked. That's why he is on top.

If I had to pick out briefly the elements which make for success, I should place intelligence first followed closely by knowledge—both general and special—acquired as you progress, strict integrity, modesty, sincerity, the ability to work with those around you, intense interest in your work which you must love, extreme faith in your own ability, faith in your fellow man, faith in our system of free enterprise, faith in our country which has given you the chance to live as a free man and prosper. And, last but not least, strong religious faith, which teaches that you must do unto others as you would that they should do unto you. With half the world steeped in atheism, our greatest need is sound religious faith—faith in God to whom we may turn for help and guidance. Alone we can do nothing.

Good luck, my boy! Fear no one; keep your chin up; rely on your own ability and hard work so that you may leave this world just a little better for your having lived, better for those who are to follow you. Never lose faith!

Reprints of this article will be supplied at $5.00 a hundred, postpaid. Quantities of less than a hundred copies are available at 8¢ each. Send requests with check (no stamps) to: The American Ordnance Association, Mills Building, Washington 6, D. C.

The Fortieth Annual Meeting

of the

American Ordnance Association

by invitation of

HONORABLE THOMAS S. GATES, JR.
Secretary of the Navy

and

ADMIRAL ARLEIGH BURKE
Chief of Naval Operations

will be held

Friday, May 9, 1958

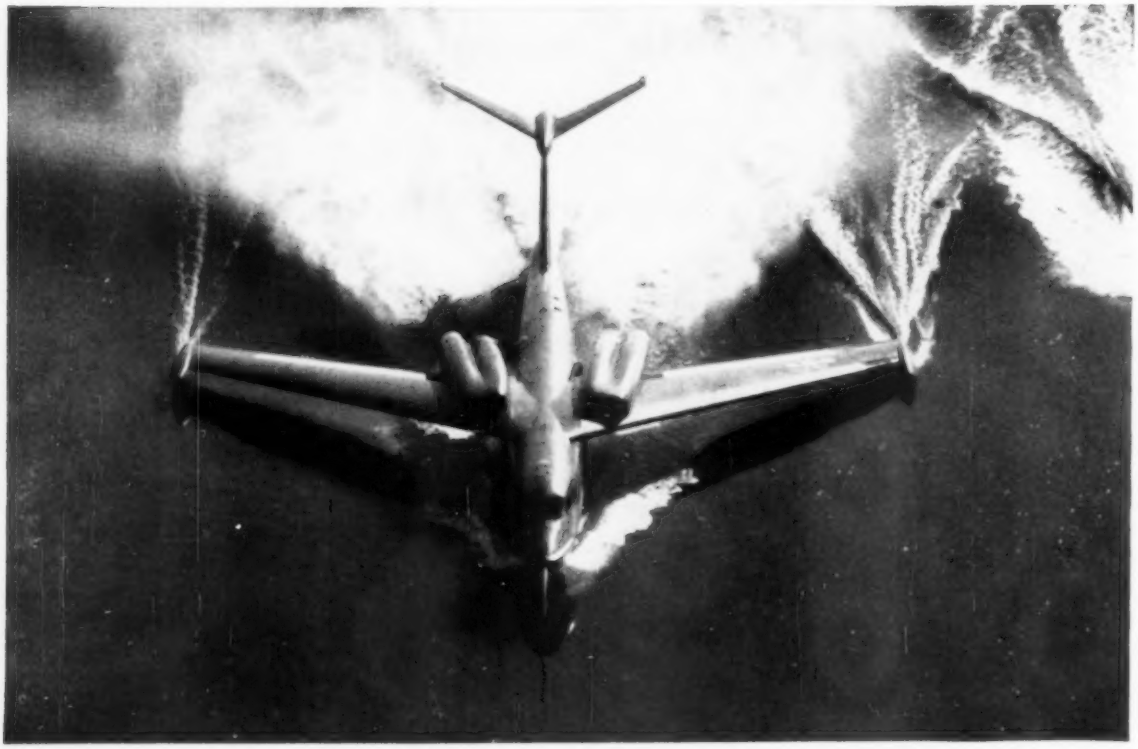
At Sea with the Navy

MEMBERS will embark at Mayport, near Jacksonville, Fla., join a task force at sea, and will be afforded an opportunity to witness current tests of latest missiles, aircraft, shipboard and undersea weapons.

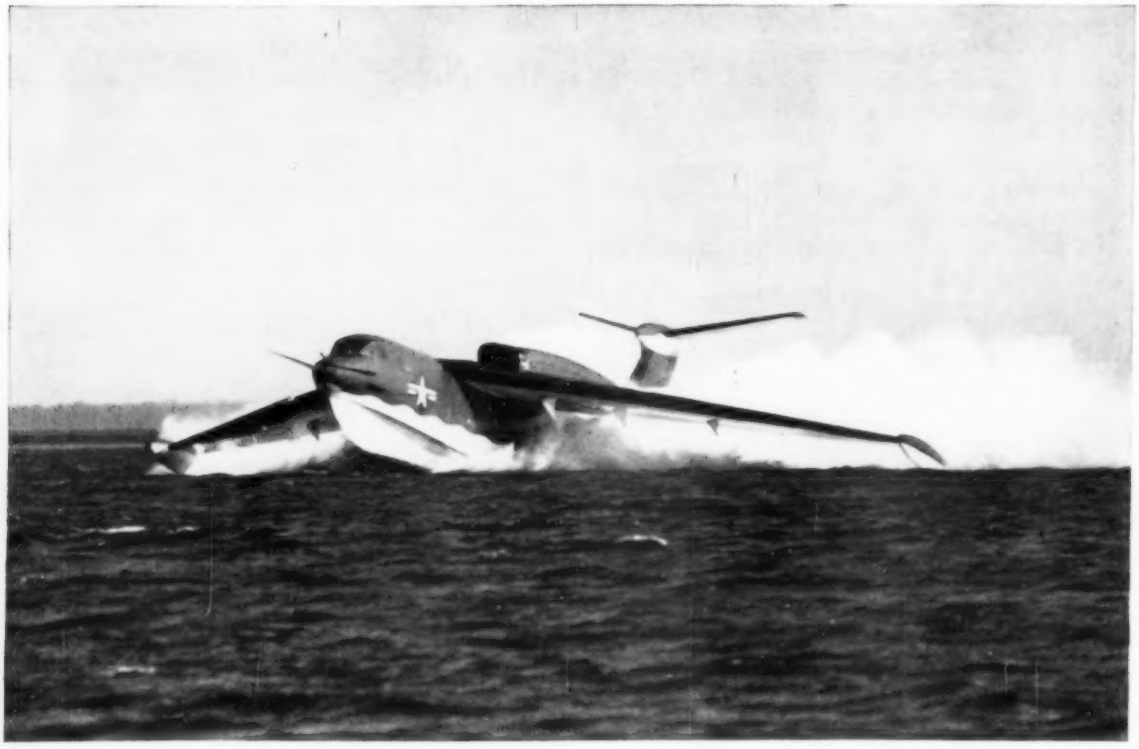
● A dinner meeting will be held on the evening preceding the tests at the George Washington Hotel, Jacksonville.

● Invitations and detailed announcements were mailed to all members of the Association, March 25, 1958. Closing date for reservations was April 24th. Only members may attend.

The SeaMaster Rides Again



The Navy's new 600-m.p.h. P6M Martin SeaMaster is shown in these photographs undergoing taxiing tests on Chesapeake Bay. The outwardly canted wing-top engine nacelles will eliminate heating of the afterbody fuselage when the inboard engine afterburners are used on take-offs. This is the first of 24 minelaying seaplanes under construction at Baltimore.



Defense Highlights: Monthly Review and Outlook

• **Reports on Space Exploration.**—Now we have three lengthy reports understandable to the layman that give a fabulous view of the forward thinking of a large body of American scientists. The American Rocket Society group was noted in these columns in the January–February issue of ORDNANCE. There, indicative of the zeal of the rocket man, a fairly concrete program of time and money was outlined.

The Earth Satellite Panel of the United States National Committee for the International Geophysical Year now has presented a program entitled "Basic Objectives of a Continuing Program of Scientific Research in Outer Space." These scientists and engineers are chairmanned by Dr. Richard W. Porter, who is on the scientific staff of General Electric Company.

This report gives in detail the many areas in basic research that should be explored through satellite programs to increase our scientific knowledge. No attempt is made to predict times or costs, but the research objectives are presented in the order of increasing complexity beginning with the moon and extending to the closer planets.

The third report, presented to the President by James R. Killian and his Science Advisory Committee, is entitled "Introduction to Outer Space." This is a primer to explain why a national space program should be undertaken. It is related more directly to the exploration of space and without detail delineates the scientific objectives by fields such as geophysics and meteorology and presents a timetable of objectives under the headings early, later, and still later.

The report also presents a finding of interest in the national-defense picture. It states that schemes for using satellites or moons as bases for launching missiles against the earth would be "clumsy and ineffective in comparison with the use of the earth as a site." The report did acknowledge the great advantage of satellites and moon observing stations for long-range communications, reconnaissance, and accurate weather prediction.

• **More Ordnance Vehicles.**—One of the first actions to help check the recession is the release of about $100,000,000 in orders to numerous truck and trailer producers for ordnance vehicles, including gas tankers, cargo trailers, and the standard military trucks used in support of combat operations.

• **Satellites and Moons.**—There is confusion between moon satellites and satellite moons in speeches and headlines. The Army's Explorer series, in which seven launchings have been authorized, is at times referred to as "moon launching." The Air Force announces that it can be ready to hit the moon late this year and somewhat thereafter fly a satellite around the moon. It is also going ahead on project Pied Piper to fly a satellite "reconnaissance" moon around the earth. Yet the Army, in the light of its successes with the Explorers, may be the first service called on to try a shot to hit the moon.

In this connection, Dr. Killian's scientific team notes that in any shot on the moon "we must be careful not to contaminate the moon's surface in a biological sense." They are concerned that evidence of any elementary form of germs or spores might be destroyed.

• **Atomic Demolition.**—In the Army's package of tricks, mention has been made of "atomic demolition material." It is assumed that these are kit-sized atomic charges for demolition of bridges and structures in the field.

• **Expenditure Bottleneck.**—Legislation to put all spending authority for the armed forces on an annual basis, the "accrued expenditure" act, will be an administrator's nightmare and an accountant's gold mine. It apparently was backed strongly by a horde of business and financial people who believed it would cut costs and increase efficiency in the Defense Department. Few seem to appreciate the Government's complex morass of financial legislation and the powers of the Bureau of the Budget, the General Accounting Office, and a chain of comptrollers throughout the Defense Establishment that complicate the expenditure of appropriations.

Too late, industry is realizing that payments often will be delayed more than ever, contracts will have to be dragged out in time, and a large corps of additional accountants hired by Defense to keep the additional records required—all at greater expense to the taxpayers. Some comptrollers even doubt that the new law can be administered at all.

• **Battleships as Auxiliaries.**—The Navy is considering converting one of its mothballed battleships into a fleet logistics supply center. The battleship could carry vast loads of ammunition and aviation gas. With its excellent sea-keeping quality and high speed, it could resupply a dispersed task force better than the standard fleet auxiliaries now in use. Funds for conversion may be requested in the 1960 program.

• **Missile Progress.**—Missile developments continue at an ever-accelerating pace. The Air Force has embarked on a major program to develop a solid-fuel IRBM to be called Minuteman. There is little duplication here with the Navy's Polaris, according to Maj. Gen. B. A. Schriever, Commander, Air Force Ballistic Missile Command, who claimed that "the problems associated with launching missiles from a submarine are vastly different than problems of launching missiles from the ground."

There is also the Pershing solid-rocket project under Army Ordnance. Redstones, Bomarcs, Thors, and Jupiters, and several lesser missiles have been successfully roaring off the pads at Cape Canaveral; key components of the Army's Plato antimissile system have been tested; Army's solid-propellant Sergeant is being readied to replace the Corporal missile; and Air Force will have its first Thor missile squadron combat-ready in June, to be followed by a Jupiter squadron in the fall.

Approximately 13,000 Sidewinder air-to-air missiles and 16,000 Nike Ajax ground-to-air missiles have been built or ordered. The Air Force's advanced type of Bomarc surface-to-air missile and the Navy's Regulus II are ready for production.

• **New Navy Ordnance.**—Rear Adm. F. S. Withington, in his final conference before being relieved as Chief of the Navy Bureau of Ordnance, revealed some features of the Navy's war capability that have not been stressed heretofore. He predicted that the first test of an operational model of Polaris would be from a stationary launcher by September 1959; such tests to be followed by firings from a moving launcher, a shipboard launcher, and finally from a submarine. He explained the increased thrust in the latest solid propellants was obtained in part by metal additives such as powdered aluminum. Some test vehicles already have been fired.

The range of the Navy's underwater tracking and detecting systems is now about 3½ miles, a vast improvement over World War II.

He also mentioned a "swimming mine" which can be pointed to travel into an enemy harbor and programmed to sink and be activated as a shallow-water mine.

Admiral Withington commented on some areas where quantum improvements are sought, such as increased range for air-search radars, higher-speed torpedoes for use against atomic-powered submarines, and the need to speed up construction of missile-firing ships for which present funds are limited to $1.5 billion.

In his new duty as Commander, Naval Forces, Japan, Admiral Withington will have as his primary task assisting the Japanese to build up their naval forces.

• **Manpower for Atomic Warfare.**—Evaluation of exercise Saber Hawk, conducted by the United States Seventh Army in Germany using over 100,000 men, shows that "at least as much manpower will be required in atomic warfare as in conventional." Both aggressor and defender in the exercise used numbers of simulated atomic weapons and employed small battle units widely dispersed. The heavy demand for replacements, including fully organized battalions, rapidly drained the available manpower.

• **Advanced Research.**—Roy W. Johnson, formerly a vice-president and group executive of General Electric Company, as Director of the newly established Advanced Research Projects Agency, has organized his top staff for action. His immediate assistants, all men of highest caliber in science or technology, are: Deputy Director, Rear Adm. J. E. Clarke, formerly the Navy's guided-missile director; L. P. Gise, formerly assistant director of the Division of Military Application, Atomic Energy Commission; and L. L. Lind, on leave from Ebasco Services Company.

Another member of the team, Dr. H. F. York, director of the Radiation Laboratory at Livermore, Calif., will serve as chief scientist as well as with the Institute of Defense Analysis. The latter is an association of universities that operates under the direction of the Weapons Systems Evaluation Group, headed by Vice Adm. J. H. Sides in the Office of the Secretary of Defense.

• **Undersea Oil Tankers.**—A giant submarine oil tanker is under study by the Maritime Commission which has asked General Dynamics Corporation to make a feasibility study on a nuclear-powered, undersea craft to run just below the surface at 35 knots, as against 18 knots top speed for a surface tanker. The advantages expected are the elimination of lost time in heavy weather, lower hull costs, and smaller crews, although a large hazard pay bonus would have to be added.

At the same time, Mitchell Engineering, Ltd., and other scientific organizations in England have been making plans and models for a similar nuclear-powered undersea tanker for Great Britain.

• **Guns to Missiles?**—The U. S. Naval Gun Factory in Washington, D. C., is in production on missile launchers and other items of naval ordnance. When Rear Adm. F. S. Withington stated recently that "there is little need for continuing activity in the gun shop itself," he alarmed many who don't know that the gun shop is just one of the many assembly, production, and test shops in the N.G.F.

The Naval Gun Factory always has been an important keystone in naval ordnance development. It employs some of the most skilled machinists and ordnancemen in the country. It is well equipped in its many shops to undertake all types of prototype work and small-lot production, where the greatest accuracy is called for. Both designers and machinists appreciate the exacting requirements of seaborne ordnance.

American Ordnance Association members have proposed various name changes such as Naval Missile Factory and Naval Weapon Development Agency to emphasize the present rôle of the N.G.F.

• **Manned Aircraft.**—While the glamour of missiles captures the headlines, Maj. Gen. James Ferguson, Director of Requirements, Air Force Headquarters, insisted: "With all their capability, the destructive power of the missile is not equal to that of the manned bomber." He predicted that we could never fight entirely without aircraft where man could observe and take corrective action to ensure combat reliability against cleverly hidden targets. He was alarmed by those elements in the country who would stampede the Air Force "into outer space, leaving little else behind."

Space Weapons, Too

An Editorial

THE editors are confident that readers of this journal will approve of the new addition to the title of the publication (see front cover). Space weapons have been added! The generic term "ordnance" has always included, as it does today, all types of weapons—the new as well as the old, the conventional as well as the most modern. And in the latter area weaponry is about to move into space.

Space satellites with their impressive possibilities in the area of armament for national defense within the past year have become a potential factor for the maintenance of world peace. Hence in future, these pages will contain discussions of space weapons by researchers in this unknown and untried field.

Here is a fitting opportunity to mention some of the erroneous definitions, ideas, and philosophies which, from time to time, grow up and become popular about the true meaning of ordnance. "Ordnance" is an all-inclusive term and embraces every type of weapon whether used on land, at sea, under the sea, in the air, or in space.

THE preamble to the constitution of the American Ordnance Association spells this out in more detail. It defines ordnance as: "All weapons, armament, and appurtenances for their operation and maintenance, whether land-based, on or under the sea, airborne, or in space, including—

"All ammunition and its chemical, metallurgical, and atomic components.

"All guided missiles and rockets. All bombs, torpedoes, depth charges, and mines.

"All combat vehicles, tanks, tank destroyers, and weapon carriers. All vehicles for automotive transport of personnel and matériel on land.

"All optical, aërial, mechanical, electrical, and electronic systems for guiding and homing missiles and for locating and tracking targets on land, at sea, and in the air."

Prevalent these days, even in high military circles, is the flamboyant use of the term "hardware" for the traditional word "ordnance." Such semantics downgrade the more important and descriptive terminology and therefore tend to lower emphasis on the serious problems involved in the design and production of superior weapons.

Few other classes of things require the scientific and practical application inherent in the research and development of modern weapons. Hence this use of the word "hardware" when ordnance is referred to simply detracts from the real significance of the latter term. Such cavalier disregard underrates the seriousness of the subject and the importance of the myriad steps that are required before a successful weapon is produced.

In this same vein it is appropriate to cite another easy term which is gaining in prominence these days. We refer to "weapons systems"—gigantic and baffling though they are. The terminology is used with easy grace, often implying that the countless factors of weaponry which go to make up the system are in themselves rather minor.

The weapons-system concept basically is not new. All weapons of every size and function from time immemorial have involved a system—the human being armed with a rifle and its ammunition is the simplest and yet a vitally important weapons system. So, too, the complex of skills, techniques, and components which comprise the successful use of rockets and missiles comprise a weapons system.

But the term has come to signify in the popular mind a single problem rather than the vast complex of individual problems as they relate to each major component of a system. The term furthermore has been enlarged in scope to include logistics, training, and similar aspects that intrude into other military fields.

Here, again, the established term "ordnance" implies now, as it always has in the past, the complete weapon that delivers its destructive power with maximum accuracy on the target irrespective of the intricacy of the system or its cost in time and effort.

And, finally, on this subject of misapplied terms there is the one which so appeals to some orators and columnists—the "ultimate" or the "absolute weapon." Unless history is to be completely disregarded and tradition entirely forsaken, the absolute weapon ages ago was proved to be the trained human individual and not any one weapon with which he protects himself and his fellows. It will be a mistake of tragic proportions if in our concern for modernity we overlook the simple and incontestable fact that it is man himself who wages war and not the weapon he has at hand.

Weaponry is but a means to an end. To hold otherwise is to challenge the classical statement of Lord Raglan who, with typical wit and profound logic said: "To claim that a man fights because he has a gun is like saying that he plays golf because he has a niblick."

THESE reflections grow out of the fact that this magazine and indeed the Association it represents will turn their attention as the need requires and research warrants to space weapons along with all the other categories of armament—tried and untried. In so doing, all of us will be wise if the process contains a balanced mixture of the future as well as the present and the past. In these days of terrifying change it would be foolhardy to cling to the obsolete. But it would be equally stupid to renounce the proved for the unconventional; it would be injudicious to promote the untried by underselling the tried.

In this concept of weapons progress based on balance lies the path to adequate national defense in all the areas in which mankind in this modern age is capable of operating—or thinks he will be.

ASSOCIATION AFFAIRS

Secretary Higgins Is Guest Of Honor At Meeting Of Jamestown Chapter

Hon. Frank H. Higgins, Assistant Secretary of the Army—Logistics, was the honor guest and principal speaker at a dinner meeting at Jamestown, N. Y., on January 28, 1958. The meeting was sponsored by the Jamestown Chapter of the Empire Post and by the Jamestown Manufacturers Association.

Assistant Secretary Frank H. Higgins, left, is shown addressing the Jamestown Chapter. Seated, left to right, are: C. E. Norquist, Chapter chairman; Maj. Gen. F. A. Hansen, chief of Ordnance Field Service; Col. A. S. Young, chief, Rochester Air Procurement Office; W. A. Taylor and R. H. Turner, Manufacturers Association.

The chairman of the meeting and toastmaster was C. Earl Norquist, president of the Jamestown Chapter and president of Norquist Products, Inc. More than 300 leaders of industry in the area braved inclement weather and deep snow to attend.

Secretary Higgins spoke on "The Business Side of the Army." He stressed the steps that are being taken for further efficiency and economy in the operations of the Army's vast logistical organization. He complimented the representatives of industry who were present for their participation in the production programs, past and present, and urged their continued support of the Army's endeavors toward maximum output based on greater efficiency.

Present at the meeting were senior members of the Army, Navy, and Air Force in the Jamestown area. Claude Wright, president of the Empire Post with headquarters in Rochester, was among the special guests, as also were officials of the Jamestown Chapter and the Manufacturers Association.

The invocation was given by the Rev. George O'Pray, rector, St. Luke's Episcopal Church. The Hon. Carl Sanford, Mayor of the City of Jamestown, welcomed the guests, and special introductions were made by Comdr. William A. Taylor. A report on the activities and progress of the Ordnance Association was given by its executive vice-president, Col. Leo A. Codd.

The committee of the Jamestown group in charge of the meeting in addition to Mr. Norquist as chairman were: William Joyce, vice-chairman, Carl T. Bergstrom, Don Braley, Lloyd Cummings, Reginald Lenna, Clare Limberg, Charles E. Norquist, Jr., Dr. Arthur Swanson, and William A. Taylor.

Admiral Goldthwaite Speaks To Lone Star Post On The Navy And The Missile Age

The Lone Star Post held its winter meeting on Friday, February 28th, at the Dallas Athletic Club, Dallas, Tex. There was a large crowd of members and their ladies on hand to greet the guest of honor, Vice Adm. Robert Goldthwaite, Chief of Naval Air Training, and a group of distinguished Army, Navy, and Air Force senior officers. Also on hand were some of the officers and directors of the A.O.A. student Chapter at Texas Agricultural and Mechanical College.

Post President R. C. Blaylock presided, welcomed the members, and, after a brief report on Post affairs, introduced the guest of honor.

Admiral Goldthwaite, who makes his headquarters at Pensacola, Fla., spoke on "The Navy and the Missile Age." He enumerated the significant changes that have been taking place in the Navy in the past few years, brought on by the application of nuclear power and by the development of missiles. The admiral pointed out that supersonic jet aircraft are now operational in the fleet carriers and that, taken as a whole, carrier squadrons have great versatility in the ability to deliver high- or low-level attacks with a large variety of weapons.

Admiral Goldthwaite also touched on the employment of the missiles, Regulus and Polaris. In the underwater field, he described the terrific problems of anti-submarine warfare and the part of the carrier aircraft in meeting this threat. He emphasized that whereas the Polaris-launching submarine would be an addition to our deterrent threat, the carrier would always play an essential part in fighting a limited war. Admiral Goldthwaite closed by stating that: "The Navy has no ambitions to grow bigger for bigness' sake, to do anything alone, or to make any undue claims. We do feel that there is a definite need for a strong, modern Navy in the missile age. We believe that our special tasks and the capabilities of the Navy and Marines are most essential."

Vice Adm. Robert Goldthwaite, Chief of Naval Air Training, left, chats with Lone Star Post President R. C. Blaylock.

San Diego Post Of A.O.A. Honors Mr. K. J. Bossart

The local Chapter of the Los Angeles Post met at the Admiral Kidd Club, San Diego, Calif., on Thursday, January 23rd to honor K. J. Bossart, technical director of Convair Astronautics.

Chapter President D. B. Acker, presided and introduced Curtis Bates, assistant chief engineer, Ryan Aeronautical Company, as toastmaster, who welcomed the guests and called on R. C. Geffs, formerly a president of the Los Angeles Post and a member of the Council of the national Association. Mr. Geffs gave a brief talk on the aims of the A.O.A.

Mr. Bossart was introduced as "the father of the Atlas" and then was presented with an award for his work on this missile and for outstanding achievements in the field of astronautics.

Mr. Bossart accepted the medal on behalf of the many men and women who helped him on his job, often "beyond the call of duty." He also praised the Convair management for risking capital on an intercontinental missile project in the period from 1947 to 1951 without government support. He predicted that the next step after unmanned earth satellites would be unmanned space vehicles orbiting the moon with scientific instruments.

Capital Post Hears About Polaris Missile Project From Admiral Raborn

The Capital Cities Post winter meeting on March 6th at the Edison Club in Rexford, N. Y., brought out many members from near-by Schenectady, Albany, and Troy. A contingent of 40 from Pittsfield, Mass., and a group of visiting Iranian army officers led by Maj. Gen. Mohamad Daftari, swelled the crowd to over 200, all keenly interested in meeting the guest of honor, Rear Adm. W. F. Raborn, Director of Special Projects, Navy Bureau of Ordnance.

Post President Al DeMont as presiding officer made brief reports on the membership and financial status of the organization and announced the four new directors of the Post: Prof. A. A. Booth, Rensselaer Polytechnic Institute; Col. E. S. Mathews, commanding officer, Watervliet Arsenal; E. S. Webster, Watervliet, N. Y. (all of whom were reelected); and Vice Adm. W. D. Leggett, Alco Products, Inc.

A brief report on the Fortieth Annual Meeting plans and general progress in the Association was presented by Capt. J. M. P. Wright of A.O.A. headquarters.

Col. George H. Metcalf, U.S.A.F. Reserve, and manager of the special defense projects department, General Electric Company, was called upon to introduce the guest speaker.

Admiral Raborn discussed in interesting detail the Navy's Polaris missile project for which he is responsible. He explained the reasons for separating the Jupiter and Polaris projects and described the manner in which the Polaris weapon system was carefully planned with goals and schedules worked out in advance. He reported on the status of the various parts of the program and confirmed 1960 as the year for the first operational Polaris system.

The Admiral noted that his project was purely a retaliatory, deterrent weapon, designed for nuclear warhead delivery into any vital spot of a potential enemy.

The Polaris weapon system, in the belief of the Navy, held such great promise that strong recommendation was being made to increase the number of launching submarines from three to nine, Admiral Raborn said.

In closing, he pointed out that a nuclear conflict was almost unthinkable and that atomic warfare probably could not be limited; therefore it was essential that the United States retain strong forces to fight conventionally against piecemeal aggressions.

Attending Capital Cities Post meeting were, left to right: Rear Adm. W. F. Raborn, Director of Special Projects, Navy Bureau of Ordnance; A. M. DeMont, Post president; and Lieut. Col. Charles H. Stephens of Watervliet Arsenal, N. Y.

New Sections Are Created In Organization Of Guided Missile & Rocket Division

Recently a revision has been made in the structure of the Guided Missile and Rocket Division of the Association for the purpose of broadening the base of A.O.A. membership in the activities of this important group. The Division and its staff organization remain essentially unchanged: C. L. Eksergian, chairman; Weber deVore and Dr. John L. Miller, deputy chairmen; and Jesse M. Hadley, secretary.

Under the Division the following Sections have now been created: *Guidance and Control*, Dr. Daniel E. Noble, Motorola, Inc., Chicago, Ill., chairman; *Propulsion*, C. W. Guy, Rocketdyne, Division of North American Aviation, Inc., Canoga Park, Calif., chairman; *Structures*, (chairman to be announced); *Systems*, Elmer P. Wheaton, Douglas Aircraft Company, Santa Monica, Calif., chairman; *Ground Support Equipment*, E. A. Brittenham, Goodyear Aircraft Corporation, Akron, Ohio, chairman; and *Rocket (small unguided)*, David W. Fletcher, National Tube Division, U. S. Steel Corporation, Pittsburgh, Pa., chairman.

Membership in the Section will be open to A.O.A. members having a valid current business or professional interest in the area of activities covered by the Section and also having a current secret security clearance from a Department of Defense agency.

Meetings for all Section members will be held at least once a year. These meetings will cover trends in development and

matériel programs of the three services in the Section area of interest. Technical papers from industrial and scientific organizations also will be presented.

Members who wish application forms for Section membership may obtain them by writing to National A.O.A. Headquarters, Mills Building, Washington 6, D. C.

Admiral Withington Is Honored At Luncheon Meeting Of Washington Post

A special luncheon meeting of the Washington Post was held at the Mayflower Hotel, Washington, D. C., on Wednesday, February 12, to honor Rear Adm. Frederic S. Withington, Chief of the Navy Bureau of Ordnance. The gathering of over 600 members and guests exceeded any previous turnout of the Post.

After a brief reception, the meeting was called to order by Post President W. J. Sears, who welcomed the assembly and introduced the head table guests: Brig. Gen. Burton O. Lewis, staff consultant for A.O.A. Technical Divisions; Rear Adm. John T. Hayward, Assistant Chief of Naval Operations; Rear Adm. John Quinn, Deputy Chief of Ordnance, U.S.N.; Capt. Robert N. McFarlane, U.S.N., Ret., executive director, National Security Industrial Association; Rear Adm. W. F. Raborn, Director, Special Projects, Navy Bureau of Ordnance; Maj. Gen. E. P. Mechling, staff consultant for A.O.A. Technical Divisions; Rear Adm. R. E. Rose, Assistant Chief of Naval Operations; Vice Adm. George F. Hussey, Jr., director, A.O.A.; Hon. Fred A. Bantz, Assistant Secretary of the Navy for Material; Lieut. Gen. Levin H. Campbell, Jr., director, A.O.A.; Vice Adm. John H. Sides, Director, Weapons Systems Evaluation Group; John F. Floberg, member, U. S. Atomic Energy Commission; Rear Adm. A. G. Mumma, Chief, Navy Bureau of Ships; Col. Henry N. Marsh, director, A.O.A.; Rear Adm. J. E. Clark, Director, Guided Missiles Division, Office, Chief of Naval Operations; Maj. Gen. R. L. Maxwell, director, A.O.A.; Rear Adm. Thomas A. Ahroon, Assistant Chief, Navy Bureau of Ordnance; Col. Leo A. Codd, executive vice-president, A.O.A.

Mr. Sears then turned the meeting over to Gen. B. W. Chidlaw, national president of the Association and toastmaster for the occasion. General Chidlaw welcomed the large delegation of naval personnel present and pointed out that the object of the Association "is to have the finest armament in adequate quantity wherever and by whomever it may be used. That goes for firepower afloat, aloft, and ashore." General Chidlaw then summoned to the microphone the guest of honor, Admiral Withington, General Campbell, and Admiral Hussey.

Admiral Hussey read a citation to Admiral Withington that stated in part: "His inspiring leadership as Chief of the Bureau of Ordnance has been a decisive factor in the timely arming of our fleet with the new weapons of the atomic age." General Campbell then presented to Admiral Withington the Lieut. Gen. Levin H. Campbell Gold Medal, founded in his honor.

The admiral replied in a brief address that was a remarkably fine valedictory to his long career as Chief of the Navy Bureau of Ordnance that was to end on March 14th, when he left for sea duty as Commander, Naval Forces, Japan.

The admiral summed up the Navy's present and future weapons situation. He pointed to the latest operational weapons, the guided missiles Sidewinder and Terrier, the atomic depth charge Betty, and the improved torpedoes and mines. He said he did not list the Talos surface-to-air missile because it was not yet operational and "there's been too much gas and not enough missile" in recent "bragging" about missiles. For the current weapons he gave credit to his predecessors and stated that the effectiveness of his own work must await the appraisal of secret weapons not yet in service.

Admiral Withington especially pointed out that he did not concur in the hue and cry about service rivalry as he had not experienced anything but coöperation and at the present time his Bureau was engaged in 250 different projects in missile work alone for the other services. He did say that in his opinion there were "far too many committees and reviewing authorities—far too many people who have authority without responsibility . . . and too many paralyzing money controls."

He told the audience that the present trend in complexity and cost of weapons must be corrected or it will become less and less possible to defend the United States. He suggested: (1) "Ingenuity and sound thinking" in the initial engineering concept of new weapons; (2) "More realistic" specifications; (3) "Cost-conscious" engineering; (4) Use of standard stock items wherever possible; and (5) Reducing the number of missile programs that reach the prototype production stage.

Brig. Gen. W. M. Greene, Jr. Addresses Washington Post On Marine Corps Manpower

The Washington Post celebrated the onset of spring in the middle of a raging snowstorm on Thursday, March 20th, at the Army-Navy Country Club. In spite of the difficult weather conditions, over 150 members turned out for the monthly luncheon to hear Brig. Gen. Wallace M. Greene, Jr., Assistant Chief of Staff for Operations, Headquarters, U. S. Marine Corps.

First Vice-President Ernest A. Tupper presided and, after congratulating the hardy souls present, introduced the distinguished guests. At the head table were: Maj. Gen. J. G. Van Houten, commander of the Military District of Washington; Rear Adm. L. P. Ramage, director, Surface Type Warfare Division, Office of the Chief of Naval Operations; Stewart L. Magee, second vice-president, Washington Post; John Tope, Post director; George M. Riviere, national Council representative; Franklin P. Reybold, past president of the Post; and Col. Leo A. Codd, executive vice-president, A.O.A.

General Greene delivered an eloquent talk on the importance placed on man in all aspects of Marine Corps planning and training. He emphasized the stress that is placed on leadership at all echelons in the Marine Corps from the first-class private up to the senior generals. In this age of missiles and space weapons, it was most refreshing to hear emphasized the importance of man, his dignity, his discipline and tradition.

L. L. Gober Addresses Dixie Post On Technology In Missile Development

The Dixie Post meeting on Monday, March 3rd, at Williamsburg, Va., created unusual interest in that L. L. Gober, chief of engineering at Redstone Arsenal, spoke on technology in guided missile developments. Members came in from North Carolina and Richmond and visitors from Washington, D. C., to swell the crowd to over one hundred.

Post President George Svadeba presided over the meeting, which was held at the Williamsburg Lodge. The invocation was delivered by the Rev. T. Roland Wagner of Norfolk, Va. After a brief business session, Mr. Svadeba introduced the guest speaker.

Mr. Gober made some interesting comparisons on the arm-in-arm development by industry and the military in such fields as computers and electronic data-reducing machines that are an important part of

missile experimentation and development. He pointed out that such advances could have been undertaken only by the joint coöperation of industry and defense.

The Redstone engineer made special note of the fact that Army Ordnance relies heavily on industry, and its work is by no means confined to the arsenal as there are more than 1,800 contractors and subcontractors who work in close conjunction. He stated that this technique results in swifter and more efficient production than one in which an immediate prime contract is given to industry.

Mr. Gober outlined the four major projects now under way at Redstone Arsenal as follows: The Pershing, a solid-propellant missile to replace Redstone; the Redstone itself; the intermediate ballistic missile, Jupiter; and the satellite, Explorer.

After his talk, Mr. Gober showed a film on "Defense of Outer Space" that outlined the problems to be met in perfecting an antimissile missile such as the Nike Zeus, now under development.

Dimensional Standards And Metrology Division Meets At Research Center

The thirteenth annual meeting of the Dimensional Standards and Metrology Division of the American Ordnance Association was held at the Air Force Cambridge Research Center, L. G. Hanscom AFB, Bedford, Mass., on January 16, 1958. Presiding at all sessions of this meeting was Louis Polk, president of the Sheffield Corporation, vice-president of Bendix Aviation Corporation, and vice-president of the American Ordnance Association and chairman of this A.O.A. Division.

Joining with the Division at this meeting was the Yankee Post of the Association. In spite of the severe snowstorm and nonflying weather conditions, nearly 300 scientists, missile engineers, and industrial leaders turned out for this interesting and highly important technical meeting.

The program was opened promptly at 9:30 a.m. by Mr. Polk, who introduced Maj. Gen. W. W. Morgan, commander of the Cambridge Research Center. General Morgan extended a most gracious welcome to his distinguished audience and briefly outlined the assigned mission of this research center of the Air Research and Development Command and the manner in which the center was organized and functions in carrying out its technical responsibilities.

Dr. A. V. Astin, Director of the National Bureau of Standards, Washington, D. C., in his address proposed international negotiation with Great Britain and Canada to establish a standard inch, urging that efforts be made to establish the international yard based on the international meter and have it defined as 0.914-meter exactly. This would yield an international inch equal to 2.54 centimeters. This is exactly the Canadian standard inch and is about midway between the present U. S. and British standards.

The growing need for precision measurement in the making of missiles to assure reliable performance and the difficulties involved in maintaining several different standards between these countries were given as reasons for backing his proposal. Differences between these inches are measured as a hundred thousandth part of an inch, which is considerably less than tolerances of millionths of an inch which are maintained in modern industrial technology. Thus tolerances in one country would fail to meet similar tolerances in the other two.

"With the continual need for and trend to increased precision in the years ahead," Dr. Astin said, "these differences, unless resolved, will become increasingly important obstacles in the future exchange and mutual use of precision instruments and components."

Melvin Fruechtenicht of Frankford Arsenal then reported on the recent activities of the American Gage Design Committee.

Col. J. G. Schneider, chief of quality control, Air Matériel Command, reviewed the operations of the new $5 million Air Force calibration program. Under the program about 200 Air Force bases in the U. S. and overseas will be equipped with precision instruments and test equipment to support fighter and bomber fleets, radar installations, and the new missile bases.

Robert Leard of the U. S. Naval Ordnance Test Station discussed the optical equipment used in the "Measurement of the Thrust Misalignment of a Large Rocket." He referred specifically to tests made on the Mighty Mouse, a present major air-to-air defense weapon in the U. S. arsenal.

Robert Cuthill, deputy director, Industrial Operations Division, Army Ballistic Missile Agency, reported on problems of measurement in the manufacture of large missiles.

Mr. Polk, in commenting on these technical presentations, remarked that extremely small measurement has become basic to the defense of this nation. "Possibly the survival of a free world and the democratic way of life could turn upon one measurement with an accuracy of several millionths of an inch," he said.

Dr. Irvin Fullmer, of the National Bureau of Standards, gave a very interesting and comprehensive report on the present status of screw-thread standardization.

The meeting recessed at 12:15 p.m. for luncheon at the Officers' Club. The scheduled speaker at the luncheon meeting was Maj. David Simons, U.S.A.F., of the Aero Medical Laboratory, Holloman Air Force Base, N. Mex. However, Major Simons was flying east and was unable to be present due to weather conditions, so Dr. Astin substituted as guest speaker with an account of recent standardization activities in Europe.

During the afternoon session two of the key representatives of the Air Force Cambridge Research Center told of the research and operations being carried on in their laboratories. Dr. Lowell Hollingsworth, director of electronics, covered developments in air traffic control, radar, and electronic equipment. Dr. James Gallagher, director of geophysics, spoke on the findings of upper-atmosphere research and other geophysical studies under way at the center.

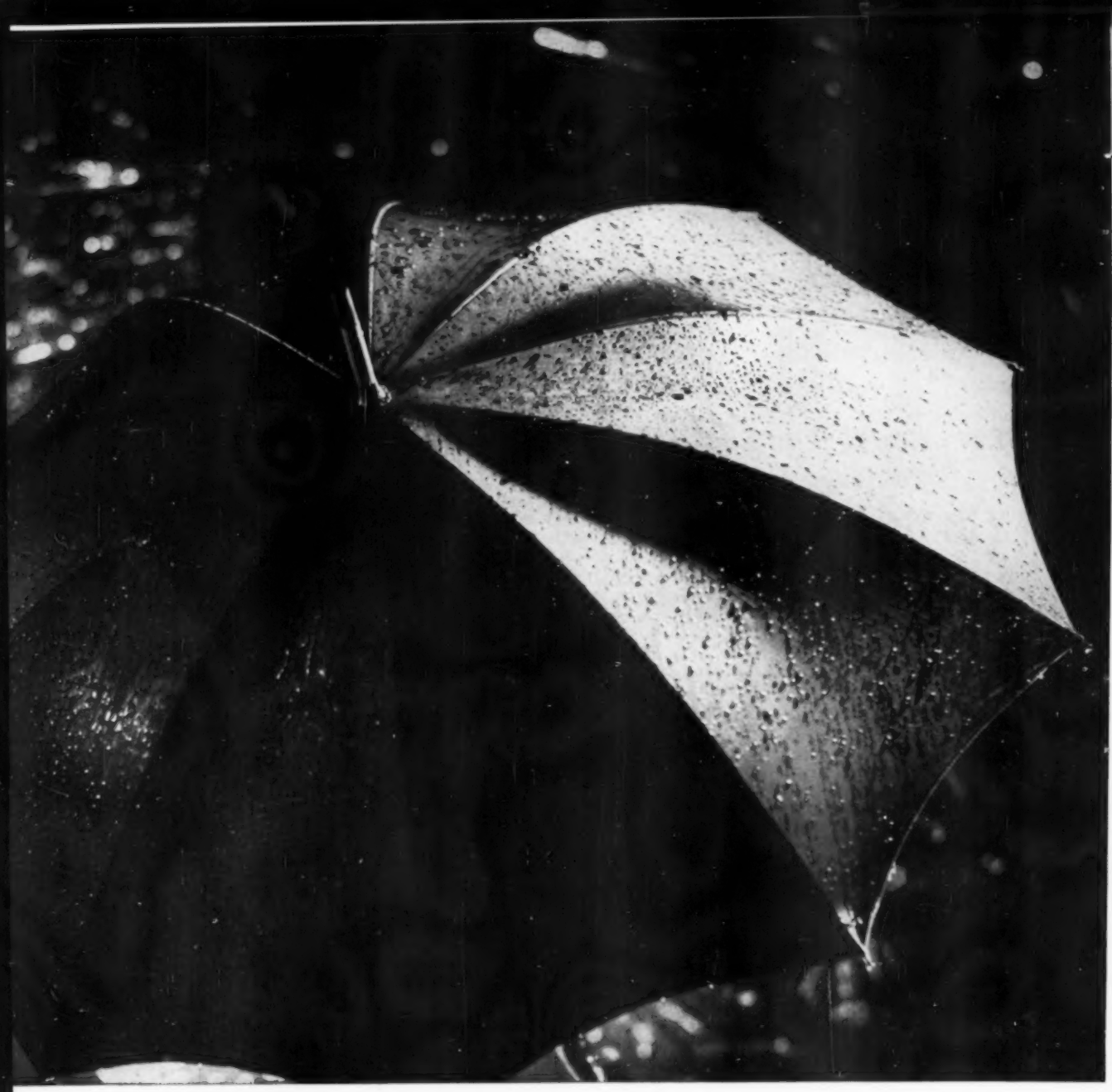
The meeting adjourned at 4 p.m. with sincere expressions of thanks to General Morgan and his efficient staff—especially Lieut. Col. Laurence B. Krogh, who was directly in charge of arrangements for the meeting.

Admiral Shands Addresses Albuquerque Post Meeting At Kirtland Air Force Base

The Albuquerque Post's winter meeting was held at Kirtland Air Force Base, N. Mex., on Thursday, March 6th. Post President Rear Adm. W. W. Juvenal, of Lytle Engineering and Manufacturing Company, was the presiding officer.

The guest speaker was Rear Adm. Courtney Shands, commander, Field Command, Armed Forces Special Weapons Project, a qualified naval aviator, who talked about the importance of variety and flexibility of atomic weapons for naval use. He covered the field in an extremely able manner in spite of the unclassified nature of his talk.

He also discussed briefly the part that Field Command, AFSWP, plays in the over-all problem of atomic weapons development for all three services and the relation of his command to the industrial and military activities in the Santa Fe operations area of the Atomic Energy Commission. (*Continued on p. 1007*)



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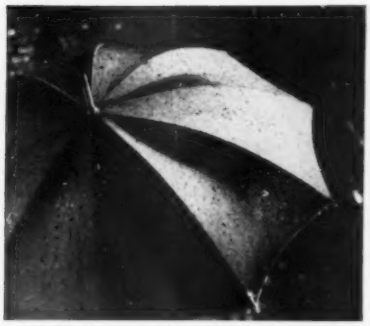

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Cumberland Valley Post Meets At Letterkenny Despite Heavy Snow

The Cumberland Valley Post met at Letterkenny Ordnance Depot on Thursday, March 13th, and brought out a sizable crowd in spite of a heavy snowstorm. This affair is best described in a letter report from the Post secretary quoted in part as follows:

"It was a bad day, for by 6 p.m. there were about six or seven inches of snow on the roads. It kept on building up so that by 8 p.m. Colonel Rader, our vice-president and the commanding officer of Letterkenny, graciously offered to house all present in the BOQ and the guest house.

"We had planned for a capacity dinner seating of eighty-four. Before I could put out on the air and in the papers that we were holding to our deadline, we had eighty-seven reservations. The storm saved our hide for we only had to feed seventy-six. After we ate, about twenty people came into the club to hear the talk.

"Bill Strauss (William Strauss, Post president) announced the Annual Meeting in Jacksonville. Several members wanted to make reservations immediately to charter a plane. If necessary, I will try to find out from the Washington Post secretary if they are planning such a deal. Now it looks as though ten or fifteen from here want in.

"We opened our meeting with Chaplain Lavey giving a blessed short invocation. Blessed it was, for we were starved! Then out came the steaks. They averaged fourteen ounces each, and were just right —sort of melted in your mouth.

"After dinner, Colonel Twomey led us upstairs and gave a most informative talk about psychological warfare (Guest of honor, Lieut. Col. Lawrence A. Twomey, Office, Chief of Special Warfare, Department of the Army, Washington, D. C.) I never before realized that it was like Gaul—divided into three parts: (1) against the troops immediately opposing our forces; (2) against the man behind the man behind the man with the gun; (3) against the whole population.

"Colonel Twomey said that in peacetime his outfit is not in action but engaged in planning and training only. Counter-psychological warfare is not the responsibility of the Army—they deal only with the enemy.

"We all began to check our antifreeze shortly after 9 p.m. and took off. Colonel Rader had gone to great lengths to ensure that we could get started and operate safely. He had the wreckers to pull us out, the firemen to help us put on chains, and cleared a path to the main highways. I don't know what more he could have done except drive us home and tuck us into bed!"

Military Pyrotechnics Committee Meets At Naval Ordnance Laboratory, Md.

The annual meeting of the Military Pyrotechnics Committee of the A.O.A. Bomb and Artillery Ammunition Division took place on March 4th and 5th at the Naval Ordnance Laboratory, White Oak, Md., and was attended by thirty-six members, consultants, and guests—an excellent turnout for the small and relatively new group.

The agenda was divided into two major subjects: The first day was to be devoted to "The Rôle of Pyrotechnics in the Armament Picture," the second to "The State of the Art" according to selected subjects contributed by members and consultants. As expected, the two subjects interlocked so that there was a frequent and animated exchange of opinions as well as of information throughout the meeting. The value of the factual exchange was enhanced by the "secret" classification of the meeting.

Special guests of the Committee were Lieut. Col. C. P. Grant, Office, Chief of Army Ordnance, and Maj. Gen. E. P. Mechling of the A.O.A. staff. Key personnel of NOL attended at least part of the meeting, including its commander, Capt. W. W. Wilbourne, U.S.N., who welcomed the assembly and opened the first day's meeting.

The Committee chairman, Dr. Herbert Ellern, Universal Match Corporation, St. Louis, Mo., conducted the meeting and, following the preliminaries, read a letter written earlier by him to Dr. James R. Killian, Jr., which, in essence, was a fervent plea to the scientific adviser of the President of the United States for a sustained, programmed, all-embracing, and truly scientific effort in the field of pyrochemistry and pyrophysics in order to lift pyrotechnics "the Cinderella of chemistry and the military sciences alike" out of its still lowly position.

The requirements and specific interests of the various branches of the Government and their agencies were next reviewed by the consultants to the Commit-

(*Continued on p. 1010*)

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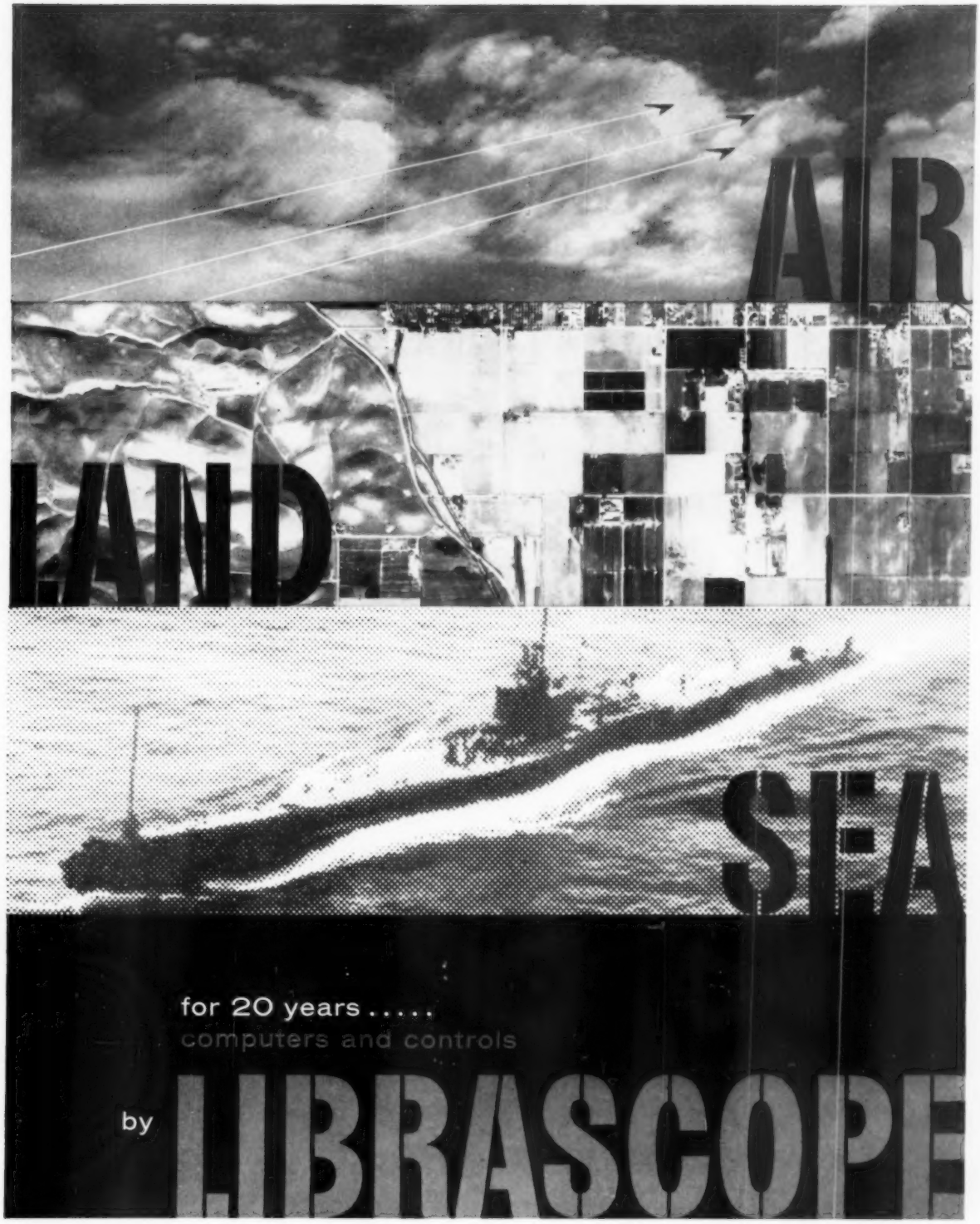

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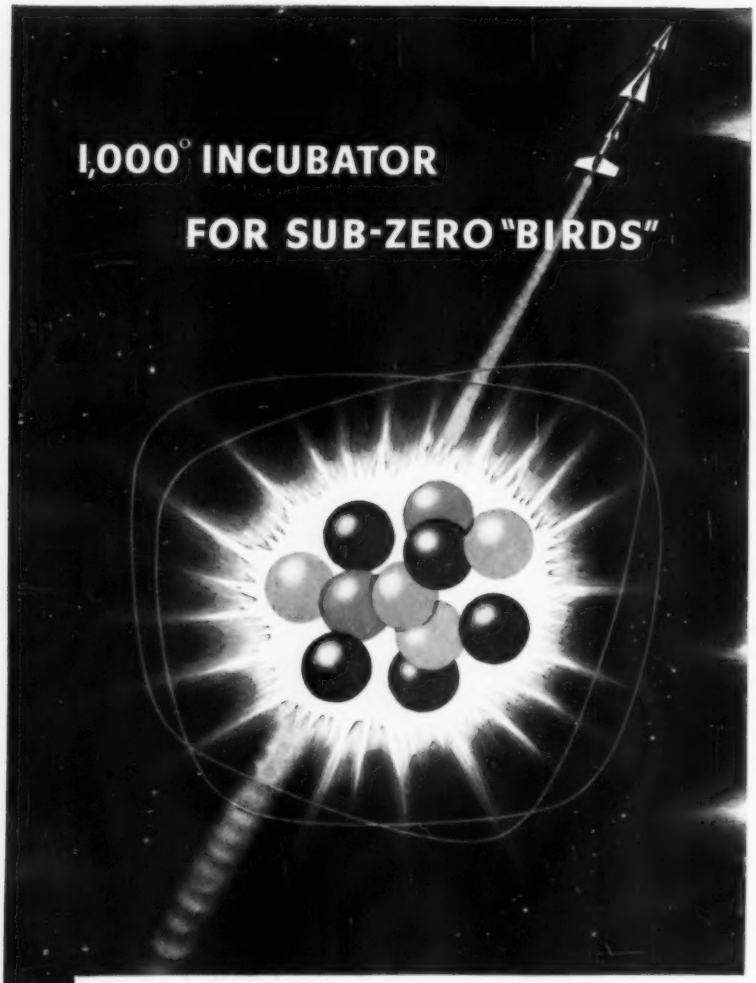

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Association Affairs (Contd.)

tee and several guests from the services. J. A. Llompart, Office, Chief of Army Ordnance, opened this part of the meeting by giving, with some humorous touches, a historical review of military pyrotechnics and the modern requirements in this field.

He was followed by R. W. Szypulski, Navy Bureau of Ordnance; Milton Lipnick, Diamond Ordnance Fuze Laboratory; John E. Teti, Army Signal Research and Development Laboratory; J. W. Sarnow, Wright Air Development Center; Eliot Belitsky, Picatinny Arsenal; M. Fry, Frankford Arsenal; E. P. Martz, Holloman Air Force Base; Dr. D. Hart, Picatinny Arsenal; James R. Quick, Wright Air Development Center; Q. C. Kaiser, and R. H. Comyn, both of Diamond Ordnance Fuze Laboratory.

These consultants and guests elaborated on their specific needs and requirements in the pyrotechnical and closely allied fields. Several presented well-documented technical papers of great interest to the group.

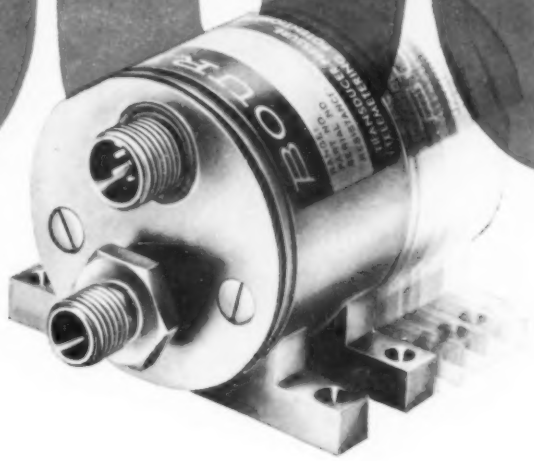
The following informal addresses or technical papers were then presented by the Committee members: R. C. Poynter, Aerojet-General Corporation, on rocket ignition; E. Elzufon, U. S. Flare Corporation, on propellant igniters; Dr. R. A. Cooley, Propellex Chemical Corporation, on squibs and cartridge-actuated devices; A. T. Wilson, National Northern Corporation, on high-altitude testing; Dr. R. W. Evans, University of Denver, on motor igniters; L. S. Love, Perry Plastics, Inc., on new plastics; and Dr. H. Ellern, Universal Match Corporation, on pyrotechnic delay timers.

Members as well as consultants were in general agreed that many users of pyrotechnical devices had only vague ideas about the availability as well as the importance of such items and that they often demand "shelf-items" where none exist or where even the functionality of a basically known device under certain operational conditions is not understood.

This false concept of treating a requirement for a squib, delay timer, explosive valve, spotting charge, heat source, power source, igniter, etc., as something of the order of an electronic vacuum tube which is put in a designated place provided for in a design study and which is of known and statistically tested acceptability, leads to unfortunate errors in scheduling, in budgeting, and eventually may reflect on the reliability of a large and extremely costly complex unit.

Modern pyrotechnics, while also important in conventional warfare, have become an adjunct to missiles and nuclear devices for activation of power sources, rocket ignition, timing and switching, and many important functions, and underestimating them means that they might be-

35G



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Capt. James K. Hoey To Receive Herbert W. Alden Award For Ordnance Studies

The Herbert W. Alden Award to the outstanding officer student graduating from the Ordnance Officer Advanced Course at Aberdeen Proving Ground will be presented to Capt. James K. Hoey.

Captain Hoey graduated from the U. S. Military Academy in June 1946. Later, at Rensselaer Polytechnic Institute he earned a master's degree in electrical engineering. Prior to his attendance at the Ordnance Officer Advanced Course he had many interesting assignments such as executive officer, Ordnance Mission, White Sands Proving Ground, and at Fort Belvoir, Va.

This award commemorates the outstanding services of Col. Herbert W. Alden of the Ordnance Reserve Corps. The award was founded through the generosity of the Timken-Detroit Axle Company, now a division of the Rockwell Spring and Axle Company, where Colonel Alden served as chief engineer for many years. In addition, he was always deeply interested in the problems of ordnance engineering.

The prize is in the form of a check for $100 that will be presented in connection with graduation exercises at the U. S. Army Ordnance School, Aberdeen Proving Ground, on July 1, 1958.

Ordnance Museum Is Making Display Of Army Weapons For Smithsonian Institution

Off to the right can be seen two World War II tanks with their guns set and ready for action; far off to the left, past the three burned-out buildings, can be seen the Army's new Honest John rocket, also ready to fire.

Between the two you can count eighteen other vehicles ranging from the Army's mighty 280-mm. cannon to the newest of tanks, to a jeep mounting the latest anti-tank missile, the Dart.

However, the trees in this scene are only nine inches tall, and the houses measure a foot, because they are all a part of an exhibit for the U. S. Army Museum at the Smithsonian Institution in Washington, D. C.

The 30-foot-long 2-sectioned display of Army Ordnance equipment is being made in the Ordnance Museum at Aberdeen

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Proving Ground, Md., under the direction of Col. G. Burling Jarrett, Ord. Res., long a member of the American Ordnance Association and its Aberdeen Proving Ground Post.

According to Colonel Jarrett the Army Ordnance phase of the exhibit will be ready in a few weeks, and the Army Museum itself will open in the Smithsonian shortly afterward.

General Medaris Is Guest Of Honor, Addresses Meeting Of Pittsburgh Post

A glittering array of leading industrial members of the Ordnance Association assembled at the Penn-Sheraton Hotel in Pittsburgh for the thirty-first annual meeting of the Pittsburgh Post on Monday March 24th.

The guest of honor for this occasion was Maj. Gen. J. B. Medaris, Commander, Army Ballistic Missile Agency, recently appointed Commanding General of the Army Ordnance Missile and Rocket Command. A special gathering was held at noon to honor General Medaris at the Duquesne Club under the auspices of United States Steel Corporation which had invited other company members of the A.O.A. and civic leaders of Pittsburgh to the affair. Here, General Medaris gave a brief, off-the-record rundown on the status of Army missile development.

Col. Robert C. Downey, president of the Post, presided at the dinner meeting. After the invocation by the Rt. Rev. Austin Pardue, Bishop of Pittsburgh, he introduced the many distinguished members and guests at the speakers' table and then called on Col. Leo A. Codd, executive vice-president of the A.O.A., who gave a review and analysis of the operations of the American Ordnance Association and especially thanked General Medaris and the industry of Pittsburgh for their consistent support of the A.O.A. over many years.

On behalf of the national Board of Directors Colonel Codd presented a certificate of appreciation to William K. Fitch, chairman of the board, Dravo Corporation, for his outstanding services as Post president from 1955 to 1957.

After being introduced eloquently by Colonel Downey, General Medaris spoke on, " the grave challenge which confronts us" and the need for "a broad national program which has as its ultimate objective the mastery of space."

He reported briefly on what already has been accomplished in this area and cautioned the audience on becoming complacent over the recent success of our own explorations by satellite. He outlined the useful information that has been obtained from Explorer and described the extreme perfection required in the production of both satellites and missiles.

"To the scientist," General Medaris said, "the Explorer is much more than an object hurtling through space at 18,000 miles an hour. It offers him a laboratory of entirely unprecedented value which is, in reality, a decisive forward step in our effort to learn more about the earth and sky."

After pointing out the military threat that is imposed by an aggressive country which may control space, General Medaris enumerated the weapons that the Army has under development to counteract such threats. He concluded by stating:

"The overriding importance of space exploration takes on proper significance only if we appreciate that it will make possible a new understanding of man's relationship with the infinity of Divine Creation. If we fail to read the signs aright, we may find progress preëmpted by the agents of the antichrist with awful consequences."

Members and guests at the head table were: G. G. Beard, president, United Engineering & Foundry Company; Davitt S. Bell, president, Edgewater Steel Company; Lieut. Col. Frank A. Bogart, commanding officer, Pittsburgh Ordnance District; Frank R. Denton, vice-chairman, Mellon National Bank & Trust Company; T. H. Eddy, treasurer, George A. Kelly Company; Col. Robert E. Fancher, U.S.A.F., 2253rd Air Base Group; Fred C. Foy, president, Koppers Company, Inc.; Lorenz Iversen, president, Mesta Machine Company; Adm. Ben Morcell, chairman, Jones & Laughlin Steel Corporation; W. S. Rial, Jr., president, Morrison Rubber Company; Gen. Matthew B. Ridgway, chairman, board of trustees, Mellon Institute of Industrial Research; Col. W. F. Rockwell, chairman, Rockwell Manufacturing Company; S. A. Swensrud, chairman, Public Auditorium Authority; I. W. Wilson, chairman, Aluminum Company of America; and Col. Yale H. Wolfe, 18th Antiaircraft Group.

• **ARDE BULOVA**, chairman of the board, Bulova Watch Company and long a member of the American Ordnance Association, died at Encino, Calif., on March 19, 1958.

Mr. Bulova was appointed chairman of the board of the Bulova Watch Company in 1930, succeeding his father who founded this well-known watchmaking concern. In addition to his interest in the American Ordnance Association's affairs, he was a strong advocate of rehabilitation and vocational training and in 1945 founded the Joseph Bulova School of Watchmaking, primarily to aid the physically handicapped. He also was greatly interested in the radio broadcasting field and owned several stations.

Mr. Bulova was a Chevalier of the French Legion of Honor and held many other national and international honors.

• **HERBERT B. LURIA**, for many years a member of the American Ordnance Association, died at Danbury, Conn., March 11, 1958. He was president of the Luria Steel & Trading Corporation and was well-known throughout American industry.

Mr. Luria was a graduate of Yale University, class of 1927. He founded the Luria Engineering Company of which he also was president. This company is a leading designer of industrial plants, aircraft hangars, and similar installations. The company has plants in Bethlehem, Pa., and Chicago, Ill. Its main offices are in New York City.

Herbert was a brother of Henry T. Luria, a past president of the New York Post of the Association and presently a member of the Board of Directors of the national organization. He served with distinction with the Ordnance Department of the Army in the Second World War.

• **RAYMOND L. MORRISSEY**, an active member of the American Ordnance Association and for the past nine years manager of manufacturing engineering of the Ford Motor Company's Engine Division, died at Dearborn, Mich., February 17, 1958. He was active in the affairs of the Michigan Post of the Association and took an especially prominent part in the recent meeting of that Post at Dearborn.

Prior to his becoming a member of the Ford organization, Mr. Morrissey had been New York District Manager of the Cincinnati Milling Machine Company. Subsequently, he was a vice-president of the Cross Tool Company of Detroit.

• **ROBERT P. WILLIAMS, JR.**, a director of the Washington Post, American Ordnance Association, and well known throughout American industry, died in Washington, D. C., February 14, 1958. He served with distinction as an officer of the Ordnance Department, United States Army, in the Second World War.

A native of Columbia, Ala., Mr. Williams was graduated from the Georgia Institute of Technology and the Sheffield Scientific School at Yale University. In the Second World War he served in the Birmingham Army Ordnance District and subsequently at the Anniston Ordnance Depot.

Following his war service he headed the Washington office of the Rheem Manufacturing Company for fifteen years, serving as vice-president in charge of the company's engineering products division. Last year he formed his own firm of engineering consultants with headquarters in Washington.

In addition to his active participation in the affairs of the Ordnance Association and its Washington Post, he was a member of the Yale Club of Washington and vice-president of the Yale Engineering Association. He also was a past president of the Georgia Tech Alumni Association.

Known affectionately among his many friends as "Rip," he was especially active in the work of the Technical Divisions of the Ordnance Association and attended many of their meetings. Charitable, talented, and of genial disposition, he added immeasurably to the work of the A.O.A. for armament preparedness to which he gave generously of his time and effort.

• **F. ERIC ERICSON**, retired president of the Barden Corporation, Danbury, Conn., died on February 6, 1958, at the Memorial Hospital in New York City at the age of 59.

He founded the Barden Corporation in 1942, after twenty-five years with SKF Industries, Inc., Philadelphia, Pa. He was vice-president and general manager from 1942 until 1948, when he was elected president. He actively guided the company until 1956, when he resigned for reasons of health.

During the war years, Barden Corporation, as a subsidiary of Carl L. Norden, Inc., manufactured bearings for the famous World War II Norden bomb sight. Following that conflict, Mr. Ericson directed the company's conversion to production for commercial as well as military purposes.

(Continued on p. 1018)

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for example

VACUUM RETORTS

This heavy INCONEL Vacuum Retort is one of a number of such designs being produced by ROLOCK. Approximately 2 feet in diameter by 8 feet high, it is used for high-temperature vacuum annealing.

By entrusting such work to ROLOCK, you gain the many advantages of competent engineering supervision; production personnel thoroughly experienced in the problems and materials involved; a modern plant fully equipped for inspection and testing as well as fabrication.

Rolock facilities and skills cover a wide range of work in pressure and vacuum equipment, specialized processing carriers, furnace retorts, covers and bells, trays, tanks, fabrications and assemblies in Inconel, Incoloy, Monel, the Hastelloys, and Stainless Steels. Send us an outline of your requirements.

Put your problems up to:

3RL 550

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FOR PEACE OR

★ ★ ★ Wherever oil wells are drilled, Ideco Full-View masts are familiar sights . . . outstanding in an industry known for both its rugged and exacting requirements. These examples of advanced engineering achievement are now modified to also serve as giant launching supports for the Army's long range Redstone missiles . . . a new defense role which strengthens the nation's program for preserving the peace.

This is only one of the many ways Dresser products and services work for you every day. The petroleum industry — so vital to our future — uses Well Surveys nuclear and electronic research . . . automation and seismograph systems from Southwestern Industrial Electronics . . . drill bits from Security Engineering . . . drilling muds and chemicals from Magcobar . . . technical oilfield services from Lane-Wells . . . Guiberson oil tools . . . pumps from Pacific . . . pipe couplings and fittings from Dresser Manufacturing . . . engines and compressors from Clark . . . and Roots-Connersville positive displacement meters and rotary positive blowers.

Dresser specialized products and technical oilfield services help to locate, surface and refine the oil that strengthens our defenses and provides us with literally thousands of products which make life more comfortable, more pleasant, more secure. In the oil, gas, chemical, electronic, and other industries, Dresser products and services have become the standard of comparison the world over. Write today for a free booklet about the Dresser story.

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DEFENSE

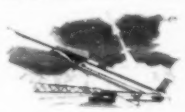
Tomorrow's Progress Planned Today!

OTHER IMPORTANT DEFENSE APPLICATIONS OF DRESSER PRODUCTS AND EQUIPMENT

Dresser Manufacturing Div. supplies flashwelded connecting rings for powerful jet engines used in military aircraft. Some types of aircraft engines require as many as 85 Dresser rings.

Roots-Connersville makes compressors and blowers for atomic submarines; gas pumps for atomic energy installations; blowers for "lifting bag" inflation to raise crashed aircraft.

Clark Turbo-Mobile power plants, rail-mounted, supply emergency electricity for Navy Yards, docks, hospitals, and major disaster areas. Unit has capacity of 6750 kilowatts, enough power for a city of 12,000.

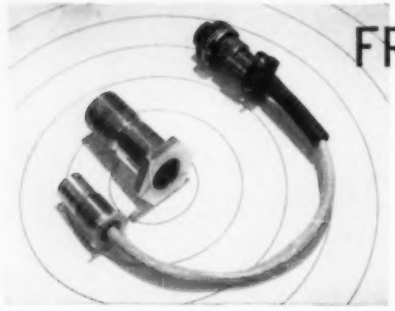


High pressure compressors from Clark . . . instrumentation and other electronic equipment from Southwestern Industrial Electronics . . . are used in guided missiles and many other important military applications.

Dresser-Ideco supplies structural equipment used in military defenses, including radar outposts for our remote Arctic warning system as well as microwave, radio and television towers.

Pacific provides the Navy with Turbo pumps for ships' main and boiler feed pumps. Equipment from other Dresser companies is also used on both merchant ships and naval vessels.

do you have these missile power problems?



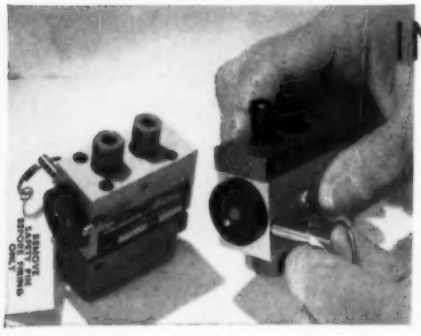
FRACTURING?

Frangible bolts from the Beckman & Whitley line combine the optimum in dependability and convenience for separating structures by electrical signal. Made to specifications, these bolts are internally threaded to receive the pre-wired charge which then attaches by standard connector to the missile circuitry provided. We'd like to help with *your* needs.

DISCONNECTING?

Double certainty of positive electrical disconnecting is provided by the selectively fired, two-charge design of this example from the line of Beckman & Whitley electrical disconnects. Shown assembled at right, this device can be provided with alternative primers as shown in the center. Shear pins hold the unaltered electrical connector assembly rigidly together until either or both primers are fired. Ideal for umbilical connections or other applications where guillotine choppers are not applicable. Perhaps these would help on *your* project.

INITIATION?



Same basic mechanism serves, right, as a detonator-safe primacord initiator, having a lanyard-operated safety pin; or, by the substitution of an explosive charge, bottom left, unit becomes a destructor. Two separate channels for top reliability, mechanism so designed that re-insertion of safety pin reverses unit from "arm" to "safe" position. If these sound too simple, we can show you some *complicated* ones.

Pre-packaged explosive power units provide higher reliability and greater power for a given weight and volume of space than any other actuation method. Some of the many other applications to valving, ejecting, fracturing, etc. may be interesting to you. Just ask us.

Beckman & Whitley INC., San Carlos 1, Calif.

Necrology (Contd.)

Mr. Ericson was born in Worcester, Mass., and attended Clark University there. An internationally recognized authority on ball bearings, he had been chairman of the Instrument Precision Ball Bearing Committee of the American Ordnance Association since it was organized in 1950. His voluntary technical service to the industrial preparedness of our nation through his constructive leadership of this Committee will never be forgotten. The magnetism of his most agreeable personality attracted to him the everlasting friendship of everyone who had the good fortune to know him.

• **FRANK BEEMER**, Philadelphia industrialist and a life member of the American Ordnance Association, died suddenly in San Francisco, Calif., March 27, 1958. He was chairman of the board of Beemer Engineering Company, Philadelphia, Pa.

Born in Springfield, Ohio, Mr. Beemer early in his career became identified with the bearing industry. He became manager of the Standard Roller Bearing Company and later vice-president of Nice Ball Bearing Company. He formed his own company which became field engineers and distributors for several nationally known manufacturers of mechanical products.

In addition to his active participation in the affairs of the American Ordnance Association, Mr. Beemer was a member of the New York Railroad Club, and the Society of Professional Engineers. He was a constant attendant at meetings and seminars of the Association and for many years was a leading figure in the annual Industrial Preparedness Meetings of the Association in New York.

• **W. H. STUEVE**, consulting engineer, a member of the board of officers and directors of the Midcontinent Post of the Ordnance Association and a life member of the society, died at his home in Oklahoma City in December 1957. He was well-known for his engineering achievements in the field of electrical distribution facilities.

Mr. Stueve was a native of Ohio. He attended Notre Dame University and Ohio State University. He had the distinction of constructing the first radio transmitter in northwest Ohio in 1900. When the Seminole Oil Field was discovered in the early 1920's, he was one of the pioneers in the use of electric power in oil-field pumping.

Following his retirement he engaged in consulting engineering and remained active in public life until his death. His services as an officer of the Midcontinent Post were deeply appreciated both by the members of the Post and by the national Association.

Bendix-Pacific HYDRAULIC EQUIPMENT

Since 1948 Bendix-Pacific has been participating in the modernization of hydraulic systems for submarines, including pioneering developments in 3000 PSI systems.

Most recent advancement is the successful development and production of high impact shock-tested hydraulic units for missile launchers, shipboard installations and other Weapon Support Equipment.

HYDRAULIC POWER SUPPLIES . . . CYLINDERS . . . SERVOS . . . DIRECTIONAL FLOW AND PRESSURE CONTROL VALVES

Guaranteeing effective missile performance at the count down...

with a GREER GO NO-GO TEST SYSTEM

Missile readiness at the launching site is assured when put through its paces with a Greer Go No-Go Test System. Take for example the above missile test facility recently completed for a leading manufacturer of missiles.*

This unique Go No-Go System automatically and accurately tests missiles off the production line. The system encompasses every type of missile test including fuel, pneumatic, hydraulic, electrical, mechanical—all equipment designed, developed and built right in the Greer plant.

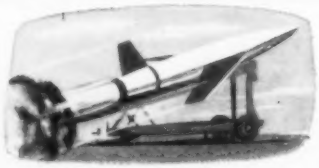
The fool-proof test system programs and schedules 32 different inputs for Go No-Go readout, and self-checks each input for accuracy before the actual test. Its special and multiple circuits provide rapid determination and isolation of defective parts in the missile. In addition, the equipment signals accurate operation of its own test circuits and components. All test conditions, altitude, speed, pressure, temperature, etc., are simulated and accurately controlled to match those in actual missile flight.

Bring your out-of-ordinary missile test problems to Greer. At your disposal is Greer's vast test equipment experience and know-how, Greer's staff of creative engineers and skilled technicians—plus a fully-equipped plant to do the job for on-time delivery. For immediate action contact Greer.

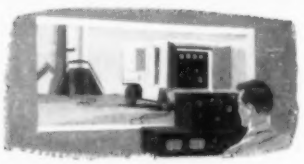
**For details, contact Greer sales manager, test equipment division.*

GREER GROUND SUPPORT EQUIPMENT

MISSILE GO NO-GO SYSTEMS



MISSILE LAUNCHING SYSTEMS



MISSILE GAS BOOSTER SYSTEMS

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ALL THE WAY
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PROTOTYPE DEVELOPMENT REQUIREMENTS
OR PRODUCTION NEEDS
NEWAY EQUIPMENT COMPANY • MUSKEGON, MICHIGAN, U.S.A.
SUSPENSION SPECIALISTS FOR THE TRUCK — TRAILER INDUSTRY

MATERIALS PROGRESS

George S. Brady

Reënforced Plastics.—Consumption of reënforced plastics in the United States in 1957, not counting molded plastics which are often reënforced with fillers, was 84,000 tons, according to estimates made by the Society of the Plastics Industry. Largest use was in transportation equipment, about fifty per cent of the total going into aircraft, boats, trucks, and trailer bodies. Another fifteen per cent of the total went into building construction and eighteen per cent into appliances and consumer products, mostly for housings. The resin content of these plastics is about half the total weight. Polyesters were the favored resins in 1957.

Navy engineers appear to be enthusiastic on the idea of reënforced plastic for personnel and utility craft, and even for other boats up to a possible one hundred feet in length. It has one 57-foot minesweeper with the hull molded in one piece. Plastic boats cost about a third less than wooden boats, and on sizes above twenty-five feet the labor savings are greater. They are easier to maintain, need no painting, and do not absorb water.

With around 150 civilian boatyards now working on plastic boats, the techniques have been improving rapidly. The stronger and more resistant epoxy resins are sometimes used, although they are more costly. Fittings and hardware are of injection-molded nylon, with nylon propellers. Water tanks and other accessories are molded into the hull for added compactness and rigidity.

High-Purity Graphite.—Only a short time ago stockpile experts were saying that only specific grades of graphite imported from overseas could be used for certain applications. It is now reported that the Germans (*Graphitwerke Kropfmuehl*) are producing compressed blocks of high-purity crystal graphite suitable for crucibles and for nuclear reactors from low-grade ore containing only twenty per cent graphite. The ground material is flotation-concentrated, purified at high heat, and pressed into blocks of controlled density.

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

Selenium Production.—Producers have cut prices of selenium from twenty-two to twenty-eight per cent, indicating a drastic change in the demand trend. With several companies now producing silicon metal on a regular commercial basis, and with the tiny silicon rectifier rapidly replacing the older, more cumbersome selenium type, selenium can no longer be classed as a strategic material. Selenium still has important uses in ceramics and for metal alloying, but with new sources coming in, supplies are more than ample. *International Nickel Company*'s new electrolysis refining of Canadian nickel matte yields selenium as a by-product.

High-Temperature Materials.—Design of missiles and rockets has called for materials to withstand heats hitherto not encountered in commercial products—temperatures sometimes ranging above 4,000 degrees Fahrenheit. Where resistance to the extremely hot gases is needed for only short periods, requirements can be met with "one-shot" materials having comparatively long burnout times.

Astrolite, of the *H. I. Thompson Fiber Glass Company*, Los Angeles, Calif., is being used for rocket-engine liners, nozzles, nose cones, and heat shields. It is a sheet material made with Refrasil (vitreous silica) fibers bonded with a heat-resistant phenolic resin. The thickness required for a 100-second burnout time at 4,500 degrees Fahrenheit is 0.390-inch, or the equivalent of a steel plate more than 1 inch thick. In weight saving, the ratio over steel is about 1 to 15.

Important in these one-shot refractories is the insulating value during the period of impingement of the hot gases. Metals and graphite have high heat conductivity and do not afford protection to the missile mechanism, while the plastic-ceramic shields have low conductivity and good insulating value. Up to seventy per cent of a missile is electronic equipment, which must be protected.

Ceramic-Coated Aluminum.—For conditions where the heat is not so extreme, *Gulton Industries, Inc.*, Metuchen, N. J., is producing ceramic-coated aluminum sheets that will withstand temperatures far above the melting point of the aluminum. A 0.040-inch aluminum sheet coated with 0.0015-inch of ceramic can withstand without damage the impingement of a flame at 2,200 degrees Fahrenheit for 2 hours, while an uncoated sheet was burned through in 30 seconds. To provide high oxidation resistance for steel parts, the *Metallizing Company of America*, Chicago, Ill., has a Borocote coating which is a chromium boride applied by flame-spraying to give a coating with a melting point of 3,750 degrees Fahrenheit and a Rockwell hardness of C65.

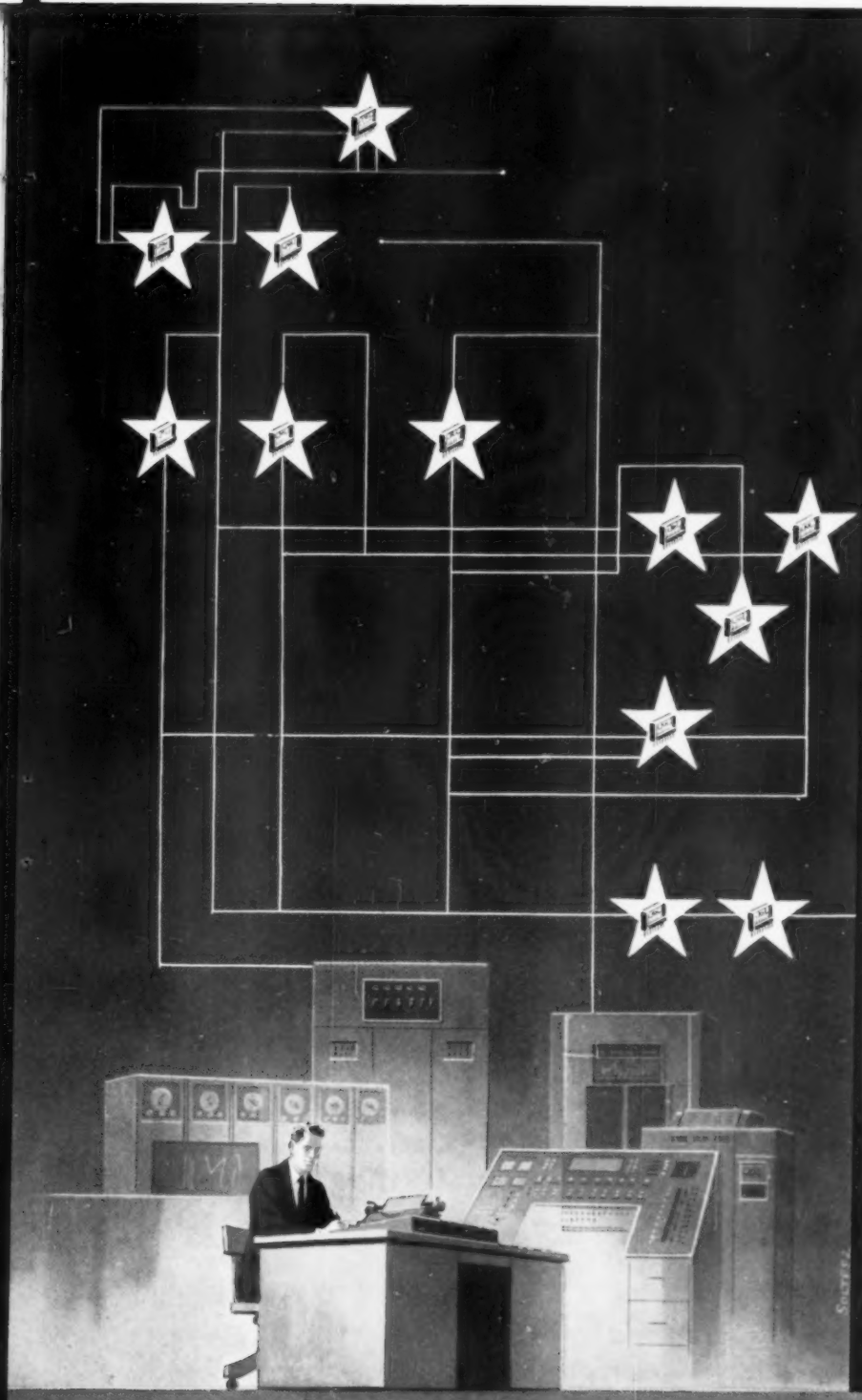
Ceramic-Insulated Wire.—*Hitemp Wires, Inc.*, Westbury, N. Y., is going into the manufacture of ceramic-insulated electrical wire that will retain its insulation resistance at continuous operating temperatures to 1,000 degrees Fahrenheit or higher. The insulation, called Ceramicite, was developed by the *Consolidated Electro-dynamics Corporation*, Pasadena, Calif., and is not a single composition but a series of ceramics of different physical characteristics for various uses. The ceramic insulation is flexible enough so that the wire may be wound around a component only twice the diameter of the wire without damage to the insulation.

Silicon Nitride.—Although not as heat resistant as some refractory ceramics, silicon nitride has proved to be well suited for rocket nozzles, crucibles, and pouring spouts for aluminum. It has high thermal shock resistance, high resistance to hot gases, and can be molded readily into intricate shapes of good dimensional stability. The slight contraction in molding is about balanced by the expansion in nitriding, so that accuracy of parts can be maintained.

Hollow parts and thin sections are made by slip casting of silicon metal powder from a water solution and then nitriding in a furnace. Shapes are made by pressing the metal powder and then nitriding, the nitrogen furnace transforming the silicon completely into the nitride. Parts produced by the *Haynes Stellite Company* have a temperature limit of 3,450 degrees Fahrenheit, a Rockwell hardness of A99, and a modulus of rupture of 10,000 pounds per square inch. With a density of about 0.12-pound per cubic inch, parts are lighter in weight than those made of aluminum oxide.

Aluminum-Tin Alloy.—*Tin Research Institute, Inc.*, Columbus, Ohio, has an-

(*Continued on p. 1024*)



Avco helps to shrink an electronic giant

What's the giant?
Today's mammoth computer.
How is it shrunk?
From the inside, electronically!

Avco research has perfected electronic 'building blocks'—miniature plug-in units, not much larger than penny matchboxes. They replace many vacuum tubes and yards of intricate wiring. Incredibly rugged, they operate perfectly at arctic or tropical temperatures... without air conditioning.

And the smaller computer they make possible can be used in hundreds of new ways... in industry and for defense. Avco 'building blocks' are already in production for a U. S. Army-U. S. Air Force *portable* computer.

Full name: Transistorized Logical Building Blocks
From: Avco's Research and Advanced Development Division

Avco today — its products are integral parts of the American scene: in homes and industry, on farms, and for defense. Avco works to give America the most dependable equipment, the most advanced ideas and research.

Scientists and engineers interested in unusual opportunities for advancement can grow with Avco.

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Avco

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nounced development of an aluminum-tin alloy for use as a bearing metal for heavily loaded high-speed bearings. The alloy contains about 20 per cent tin, 1 to 3 copper, and the balance aluminum. The copper forms an alloy with the aluminum, but the tin remains unalloyed in a reticular, or network, structure that gives a good bearing surface in the strong aluminum matrix.

Such an alloy is not entirely new, and several companies have been using aluminum-tin alloys, usually with steel backings. Some of these alloys contain up to thirty per cent tin. The 70-30 alloy has a Vickers hardness of 22. Adding 1 per cent copper raises the hardness to 27 and improves the physical properties. The cast alloy has the tin in an almost continuous intercrystalline network.

Synthetic Rubber.—There is no apparent alarm among rubber consumers over a possible loss of the supply of natural rubber from Indonesia, which area normally produces around forty per cent of the rubber supply. New and improved synthetic rubbers are appearing continuously. World consumption of synthetic rubber in 1957 was 1,345,000 long tons, and about 935,000 tons of this were consumed in the United States, or about 64 per cent of all American rubber consumption.

The proportion of synthetic used in Europe has not been so high, but since the Suez trouble interest in synthetic has increased, and at least two new plants are going up on the Continent. Even Brazil, which could produce natural rubber in quantity if it wished, is building another synthetic plant.

In the United States, new plant facilities are likely to be directed more toward "synthetic natural" rubber. *Goodyear* has been planning facilities to produce its Natsyn, which is a polymerized isoprene equivalent to natural rubber and can compete with natural rubber's most favorable price. More and better isoprene will be needed, but the chemical industry has been working on this. What to do with the large quantities of natural rubber in the Government stockpile is an unsolved problem. Cost of maintenance is heavy, and it deteriorates faster than it can be rotated conveniently.

Levitation Melting.—*Westinghouse* has developed levitation melting of such metals as zirconium, titanium, and columbium which are required in ultrapure form and are likely to pick up trace impurities from crucibles. Essentially, the process is to place pressed metal powder inside a copper coil in a vessel containing an inert gas. An extremely high frequency current passed through the coil generates a field of force that balances the metal within the coil, and the high temperature, up to 5,000 degrees Fahrenheit, melts the metal instantly. The molten metal is not in contact with the coil or with a crucible of any kind, and there is no pickup of impurities.

Titanium Parts.—*Keystone Carbon Company*, St. Marys, Pa., is now producing parts from titanium by powder metallurgy. Sintered parts of commercially pure titanium have a density of 4.20, a tensile strength of 65,000 pounds per square inch, elongation of 10 per cent, and Rockwell hardness of A50.

Chemical Battery.—Several companies are working on the idea of a chemical battery, which also has been designated as a fuel cell. So far it has not been demonstrated that the battery is a source of cheap electrical power, but it appears to have a number of attractive advantages as a source of direct current with simple equipment installation that is permanent and requires practically no maintenance expense.

National Carbon Company's battery consists merely of two hollow porous carbon electrodes passing through a potassium hydroxide electrolyte. Oxygen flows through one of the carbon electrodes and hydrogen through the other. At atmospheric pressure and a temperature of 130 degrees Fahrenheit the potential is up to 1 volt per cell. The current can be increased by increasing the pressure of the gases. At 150 pounds per square inch, the output is one kilowatt per cubic foot of cell area. There is no consumption of either electrode or electrolyte.

Commercial grades of gases can be used, but hydrogen is not a cheap gas. *Pittsburgh Consolidated Coal Company* has been working on a cell using carbon monoxide with air in the hope of being able eventually to use natural gas and air as the fuels.

New Adhesive.—A new adhesive for metal-to-metal bonding, developed by the *Rubber & Asbestos Corporation*, Bloomfield, N. J., under the name of Plymaster 1020, will give a bond on Type 320 stainless steel with a shear strength up to 1,750 pounds per square inch, and is capable of withstanding heats to 500 degrees Fahrenheit. It is an epoxy resin compound, and is supplied in the form of tape and sheet 0.020-inch thick. Another grade, Plymaster 2040, in sheets 0.040-inch thick, and supplied with a liquid primer, is being recommended for bonding steel honeycomb sandwich structures.

Resins for Paint.—Epoxy resins, with their high adhesion and durability, are gaining ground in the paint field. *Mono-Seal Products Company*, Everitt, Mass., has a new protective coating for machinery, tanks, trucks, and boats, that gives unusual resistance to weathering and to impact and abrasion. It is a blend of epoxy and silicone resins without plasticizers, and it cures both by solvent evaporation and by activator polymerization into a hard, adherent, and chemically resistant coating. It can be had in twenty-two colors as glossy, semigloss, or flat paints.

New Plastics.—*Du Pont* appears to be about ready to put into quantity production a competitor to its own well-known nylon. The new plastic, Delrin, is stated to have the highest load and fatigue resistance of any thermoplastic. It has greater stiffness and strength at elevated temperatures than nylon, and better dimensional stability for such uses as gears and bearings. The material is a polyvinyl acetal produced from formaldehyde, and it has a unique crystalline structure of alternate linkages of carbon and oxygen with about fifty per cent of oxygen by weight. It will be recommended for the production of machine and appliance parts and for such uses as handles and tableware.

The specific gravity of the material is 1.425, the melting point 347 degrees Fahrenheit, and the dielectric strength 500 volts per mil. It has high chemical resistance. The molded parts have a tensile strength of 10,000 pounds per square inch, a flexural strength of 14,000 pounds per square inch, elongation of 15 per cent, and a Rockwell hardness of M94.

What of Strategic Materials?—In the twelve years since the Congress approved a long list of industrial materials as "strategic" and necessary to be stockpiled, technical advances in synthesis and in the development of substitute and alternate materials has been so great that one wonders how much of the vast accumulated stockpile is now merely an expensive surplus. Among the questionable items at the moment are battery manganese, mica, selenium, industrial diamonds, manila hemp, kapok, quartz crystals, sapphire, graphite, shellac, talc, and various fatty oils and tannins.

Of the 6,600,000 pounds of marine cordage sold in 1957, more than 25 per cent was synthetic, mostly nylon and polyethylene, and this synthetic was largely going into the uses where hemp was once considered necessary. The high-modulus polyethylene now used for tugboat hawsers has a higher strength than hemp. *General Electric Company*, in its relatively small operation at Detroit, has already produced more than 100,000 carats of industrial diamonds in small crystals equal to the best natural diamonds for industrial abrasives.

NORTHROP AIRCRAFT, INC., ANNOUNCES

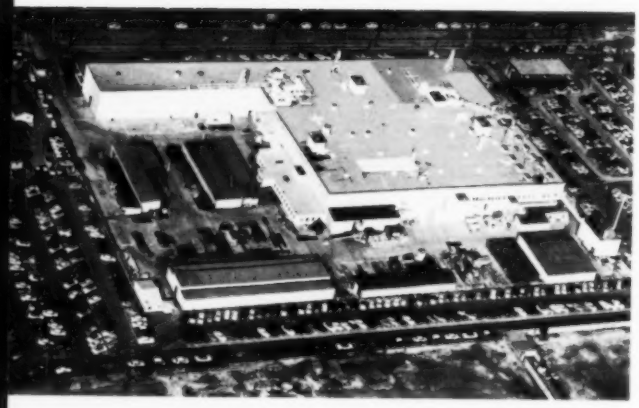
THE FORMATION OF NORTRONICS

A DIVISION OF NORTHROP AIRCRAFT, INC.

NORTRONICS

...GEARED TO THE SPACE AGE

Today, in the complex field of applied electronics, a new name, NORTRONICS, represents the combined talents of leading scientists, engineers, and technicians with production experience and capabilities. NORTRONICS, *new in name only*, is a combination of several Northrop facilities which had separately provided technical design, development, and production of electronic systems and systems support equipment. NORTRONICS provides a complete organization with the scientific knowledge, development techniques and production capabilities specifically required for the space age.

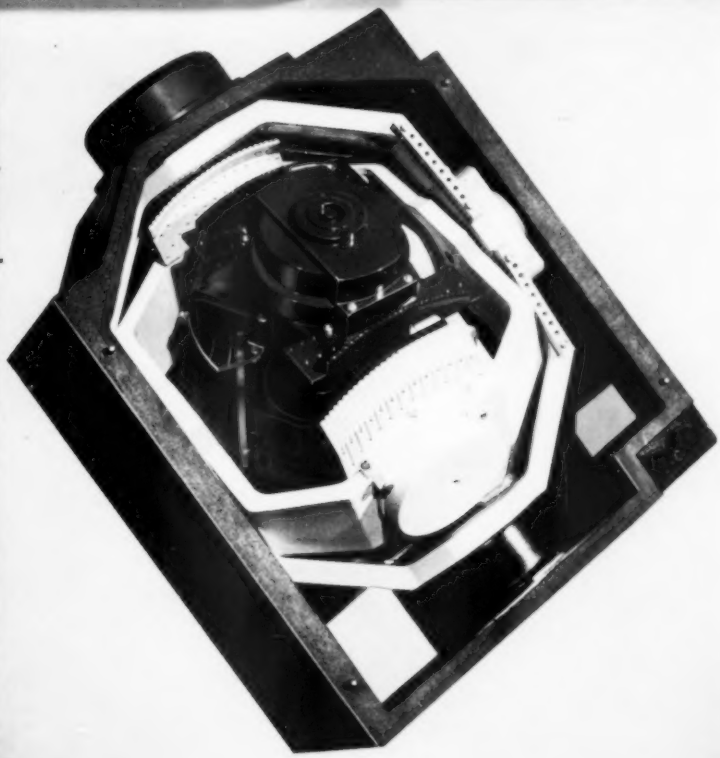


Nortronics' Electronic Systems and Equipment element, 222 North Prairie Avenue, Hawthorne, California.

In this NORTRONICS facility, comprising 300,000 square feet of plant area, Northrop established the nation's first unmanned weapon systems project. This program developed and produced the first successful systems for intercontinental inertial guidance. Today, airborne and ground based digital computers, automatic flight control systems, advanced infrared applications, and electronic and precision optical equipment are being developed and produced.

Nortronics' Systems Support element, 500 East Orangethorpe Avenue, Anaheim, California.

Here NORTRONICS is engaged in weapon systems support, including electronic test equipment; launching, loading and handling equipment; opto-mechanical fire control and sighting devices; and the most advanced techniques in physical countermeasures. The technology and facilities required to support such projects are housed in a 350,000 square foot plant area.



Compact automatic navigation system

AUTOMATIC FLIGHT CONTROL

A special research and development program of electronic miniaturization for advanced flight control application is now in progress at NORTRONICS. This is an outgrowth of nearly twenty years' experience in flight control systems for manned and pilotless aircraft. The fully powered systems on the Northrop P-61 Black Widow, the F-89 Scorpion series, and the SM-62 Snark missile were products of what is now NORTRONICS. These capabilities and production facilities are adaptable for the development of various types of flight control systems.

INFRARED INTELLIGENCE SYSTEMS

Homing systems for air-to-air missiles and infrared reconnaissance systems are natural outgrowths of development at NORTRONICS, following years of creative study. Considerable engineering development has resulted in experience in the fields of critical infrared systems and components, interference filters, reflecting optics, and sensor refrigeration.

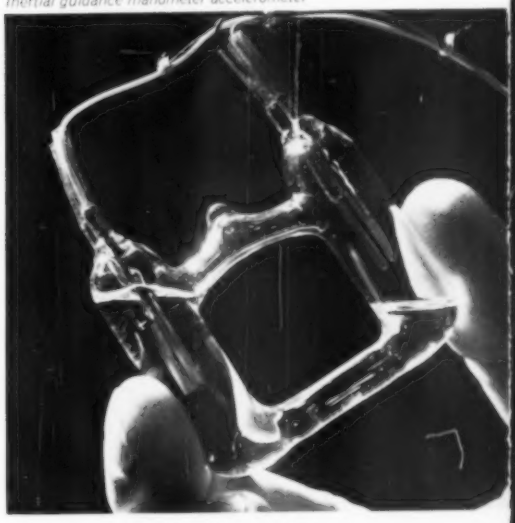
DIGITAL COMPUTERS

The engineering team that is now part of NORTRONICS developed advanced digital computing techniques employing a magnetic drum storage principle. The quadratic arc computer, identified as QUAC, followed and is now in production for the U.S.A.F. Later NORTRONICS engineers developed the first successful computer design employing the moving pick-off head principle. This computer series, known as GFC, is also in production. The requirement for lightweight, accurate airborne parabolic arc computer systems was met with APAC, a fully transistorized missile computer.

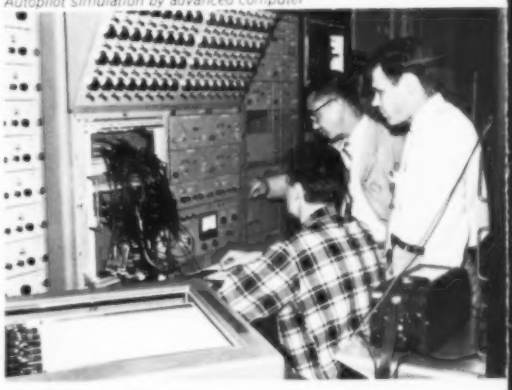
AUTOMATIC NAVIGATION

NORTRONICS scientists and technicians developed and produced the world's first successful intercontinental inertial guidance system. Aircraft and missile guidance systems of extreme accuracy and reliability, utilizing automatic star-tracking, are now in production. This vast experience has led to unique capabilities for the development of interplanetary navigation systems. NORTRONICS operates complete testing and manufacturing facilities for numerous types of automatic navigation systems.

Inertial guidance manometer accelerometer



Autopilot simulation by advanced computer



Rapid digital computer memory drum

NORTRONICS

...GEARED TO THE SPACE AGE

Scientific knowledge of the highest degree, proven development techniques, and precision production abilities are demanded in today's space age. NORTRONICS, the new Division of Northrop Aircraft, Inc., is a unique combination of these required capabilities. Here are the scientists and engineers who have created such outstanding achievements as the world's first successful automatic intercontinental missile guidance system, now being produced by NORTRONICS' skilled technicians. Exploration and discovery in every field of aerial science and weapon systems is represented in the combined experience of NORTRONICS.

1—NORTRONICS is a *complete* organization. It offers systems analyses, applied research, design, development, engineering, laboratory and flight testing. It offers special environmental test facilities, assembly line manufacturing, production of training aids and technical publications, and field services.

2—The Engineering and Research staff of NORTRONICS includes over 450 scientists and professional engineers. More than 4,500 experienced people work in 650,000 square feet of plant area.

3—NORTRONICS designs, develops, and manufactures electronic, electro-mechanical and opto-mechanical systems, components and ground support equipment. In 1957, sales amounted to $60,000,000.

4—Advanced engineering research at NORTRONICS has resulted in the development and production of several types of highly refined analog and digital computers for both airborne and ground based applications.

5—Extensive experience makes NORTRONICS an important source of weapon systems support equipment. Now in production, for example, is electronic and mechanical ground support equipment for leading United States missiles.

6—NORTRONICS' completely equipped optical laboratory is manned by technicians with unique skills and experience in developing high precision optical elements and systems.

7—NORTRONICS' scientists and engineers pioneered in celestial and inertial guidance and navigation systems. This experience is particularly applicable to the development of infrared guidance and interplanetary navigation systems.

The research facilities as well as the development and manufacturing capabilities of NORTRONICS are now supporting U.S. science, industry and military services. For further information write to: NORTRONICS, A Division of Northrop Aircraft, Inc., 222 North Prairie Avenue, Hawthorne, California.

Electronic support test equipment

Precision electro-optical development

ELECTRONIC TEST EQUIPMENT

Experience in the field of automatic test systems for complex weapons includes the design, development, and production of a complete line of operational support equipment for the SM-62 Snark missile guidance system. Latest in a series of successful test equipment is DATICO, a digital automatic tape intelligence checkout system. DATICO provides a major reduction in the time and costs involved for the testing of all types of weapons. The versatility of this equipment is demonstrated by its current application to five weapon systems.

ELECTRO-OPTICS

In one of the nation's most complete optical laboratories, NORTRONICS combines advanced navigation systems with new developments in optical science. NORTRONICS' modern optical laboratory is staffed with specialists of outstanding and unique skill and experience. Here a wide range of precision optical elements is produced, ranging from simple prisms to specially designed test equipment and precision lenses. At present, these NORTRONICS scientists and technicians are specifically qualified to conduct advanced research for interplanetary navigation.

High precision optical test equipment

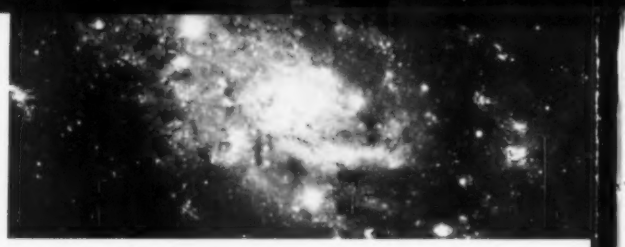
ENVIRONMENTAL TEST FACILITIES

The wide range of environmental conditions encountered by all types of electronic systems can be duplicated by NORTRONICS' extensive test facilities. Extremes of temperature, altitude, humidity, pressure, and sound frequency are simulated, as well as combinations of random and sinusoidal vibrations that occur during flight. Additional NORTRONICS testing equipment is constantly being designed and developed to meet changing requirements.

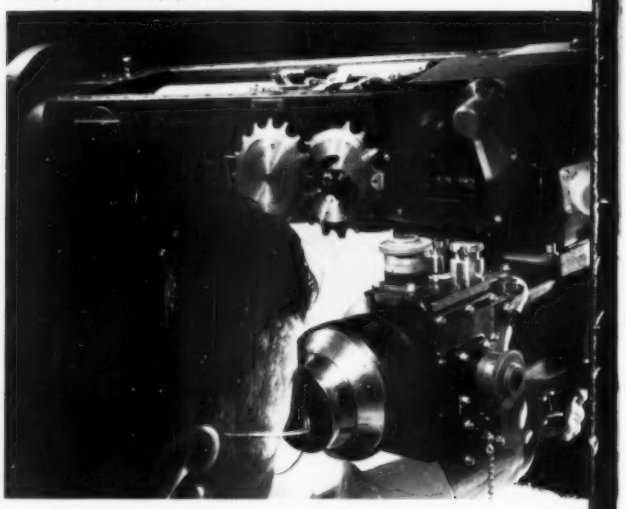
A DIVISION OF NORTHROP AIRCRAFT, INC.

FIRE CONTROL AND SIGHTING DEVICES

Experience in fire control devices and sighting sub-systems at NORTRONICS covers a wide range of production items. NORTRONICS has engineered, designed, tooled, and volume produced telescopes, periscopes, range finders, plotting devices, and calibration and alignment fixtures for military and industrial applications.



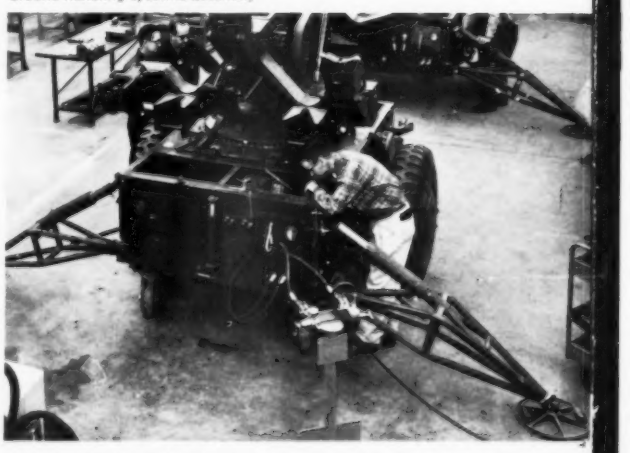
Military fire-control equipment



Ground handling systems assembly

LAUNCHING, LOADING AND HANDLING EQUIPMENT

The capabilities of NORTRONICS cover the complete range of research, design, development, production and service of universal handling equipment for major weapon components. NORTRONICS is currently supplying Raytheon Manufacturing Company with pallets, loaders, launchers, and tactical containers for the Hawk missile, and has participated in other similar programs.

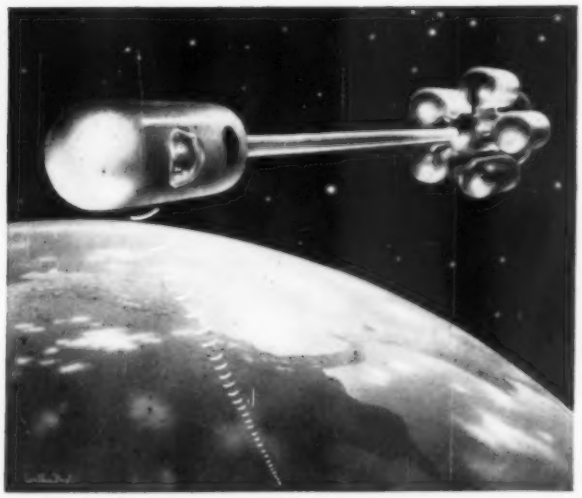


Weapon systems support equipment

SUPPORT SYSTEMS DEVELOPMENT

The design of support equipment must reflect understanding of the weapon, its operational and maintenance concepts, and the facilities and skills of its field operators. NORTRONICS' experience with military specifications, contracts and documentation, operational concepts, and the design and production of weapon systems support equipment provides maintainable precision support equipment having high reliability.

TEST INSTRUMENTS Bulova's rugged Tachometer Tester for all jet and reciprocating systems meets MIL-T-945A requirements—is accurate to 0.1% with engines on or off. Simple to operate and maintain, this field unit also serves in maintenance depots. Precise Bulova testers include the dual purpose Torqmeter—a dynamometer or calibrated torque source.



RECONNAISSANCE SYSTEMS Bulova-developed miniaturized sensor packages, geared to specific tactical missions, feed combat surveillance data to Bulova analysis and display systems. Camera, infra-red, TV and radar techniques, combined and integrated, aid decision-making on land and in space. Satellite applications? Unlimited!

Bulova's capability helps to solve today's most challenging problems

To conceive, develop and manufacture a broad range of advanced electronic and electro-mechanical devices...this is the Bulova capability.

Meeting the needs of defense and industry is an unusually creative group of scientists, engineers and technicians, backed by 80 years' experience in precision production.

With dynamic imagination, Bulova's capability has invaded the often uncharted technological areas to originate many modern-day miracles in miniaturized systems and components.

Here is a proven capability ready to assist you from concept to mass production. For full information, write Department G.I.S.-2.

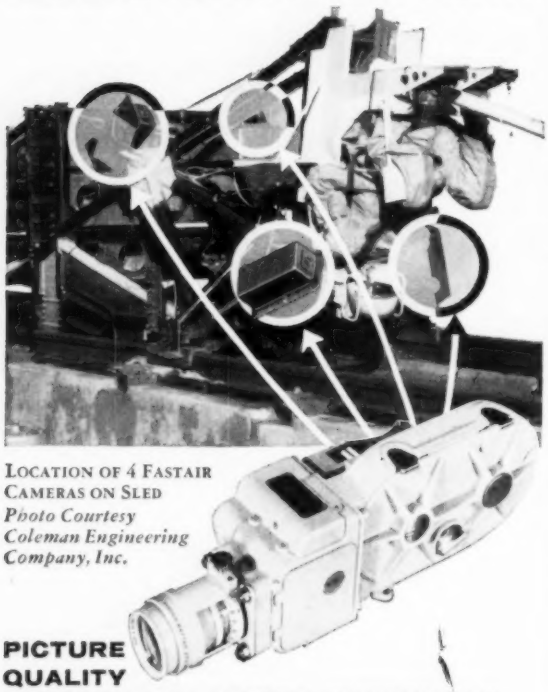
BULOVA
watch company

BULOVA RESEARCH AND DEVELOPMENT LABORATORIES, INC.
BULOVA PARK — JACKSON HEIGHTS — NEW YORK

INFRA-RED COMPONENTS Bulova's advanced IR projects include mosaic cells that will automatically filter out unwanted wave lengths and picture targets clearly against any background. Bulova infra-red R&D covers lead selenide and lead sulfide cells, missile seeker cells, reticles, filters and thermistor bolometers...for defense and industry.

INFRA-RED SYSTEMS Bulova's IR illuminators put unseen spotlights on night objectives. Bulova's development capability extends to fire control systems that detect, track and automatically lock on target. Designed for accuracy and simplicity, these high resolution units will serve our nation's land, sea and air forces.

4 FASTAIR CAMERAS RECORD ROCKET SLED TEST...



LOCATION OF 4 FASTAIR CAMERAS ON SLED
Photo Courtesy Coleman Engineering Company, Inc.

PICTURE QUALITY UNEXCELLED UNDER EXTREMELY ADVERSE CONDITIONS...

Despite the high acceleration, vibration and extreme G load of rocket sled test FASTAIR High-speed Missile Cameras recorded pictures of highest quality. Small, sturdy and compact, the FASTAIR, the first camera developed specifically for missile and rocket studies, is *unexcelled*. The FASTAIR can also be used in other fields requiring the recording of action for analyses. Speed ranges from 12 to 600 pictures per second.

Photo Unit Supervisor, Lockheed Missile Systems Divisions, Palo Alto, California

• *Robert W. Drury reports the* FASTAX *camera is a credit to the photo equipment industry . . . never had a failure of any part of the camera or the very well thought out Camera Control unit. The new* FASTAIR *camera has proven to be an outstanding missile-borne camera, well designed for the job.*

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NEW DEVELOPMENTS

HIGH-SPEED TUNNEL

Speeds up to 15,000 miles an hour and temperatures hotter than the sun's surface will be reproduced in a "hotshot" wind tunnel being built at Lockheed Missile Systems Division's research laboratory, Palo Alto, Calif. The 44-foot-long tunnel, designed to simulate conditions encountered by a high-speed missile flight through the atmosphere, will be one of several such tunnels to be used by private industry and the services.

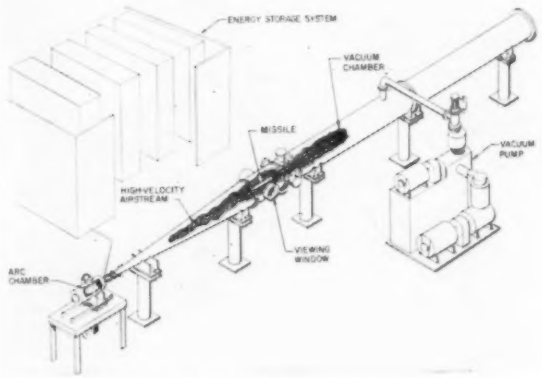

Diagram of high-speed, high-temperature tunnel.

Compressed gas in an arc chamber will be fired by a 20-million-kilowatt jolt of electricity from 320 condenser units. Gas will be heated instantly to 18,000 degrees Fahrenheit causing it to erupt through a diaphragm. Superheated air will explode through the tunnel, which has been evacuated by vacuum pump, and blast against the nose of the test missile.

SUBSURFACE SHIP

Award of a research and development contract to Aerojet-General Corporation, Azusa, Calif., to explore the feasibility of a high-speed subsurface commercial hull form that could be used to develop further the speed capability of nuclear-propelled merchant ocean craft, was announced recently by the Department of Commerce. This project is a preliminary step in scientific exploration by the Maritime Administration looking to the possible development of a fast subsurface ship employing water-jet propulsion of advanced concept. If this proves feasible, at a later date the adaptation of nuclear power to this craft may be considered.

The craft as now envisaged would resemble a submarine in shape. It would run just beneath the surface with a control gondola on a knifelike connecting strut which would carry personnel above the sea surface. The craft would possess positive buoyancy so that it will float to the surface when not in motion.

CORROSION PREVENTIVE

The National Bureau of Standards has completed a study of the electric potential needed to protect steel cathodically from corrosion in salt water. Data obtained under controlled laboratory conditions are expected to provide a basis for handling

similar problems encountered under marine conditions. It was found that the best degree of protection was achieved when the specimens were held at minus 0.77-volt with reference to a saturated calomel electrode.

NEW SPACE PROGRAMS

The Advanced Research Projects Agency of the Department of Defense will proceed with several programs for launching a number of small unmanned space vehicles. The programs authorized include both scientific earth satellites and efforts to determine our capability of exploring space in the vicinity of the moon and to obtain useful lunar data. These programs are called "lunar probes."

Authority to undertake one, and possibly two, such probes was given the Army Ballistic Missile Agency at Huntsville, Ala. ABMA also was authorized to launch two, and possibly three earth satellites. Modified Jupiter-C rockets will be used in these projects.

A program calling for three lunar probes was assigned to the Air Force Ballistic Missile Division, ARDC, Los Angeles, Calif. BMD will use a Thor-Vanguard system with a third stage to be developed. Meanwhile, the Naval Ordnance Test Station at Inyokern, Calif., was ordered to develop a mechanical ground-scanning system for use, when available, in lunar probes.

RAMJET RECORD

A Lockheed X-7 ramjet missile has blazed a new speed mark, making it the fastest "air-breathing" missile in the U. S., according to the Air Force which also revealed that an X-7 has zoomed to a record altitude for any ramjet-powered vehicle, bordering on the fringes of the earth's atmosphere.

The X-7 missile after a safe landing.

The X-7's, developed for the Air Research and Development Command by Lockheed's missile plant in Van Nuys, Calif., are being used to flight-test powerful new ramjet engines used to propel some of the Nation's advance defense weapons. The record speed run was so fast that the missile's paint was burned black by the heat of air friction.

SUBMINIATURIZATION

A process of printing transistor leads was discovered recently by two young Army scientists, Dr. J. W. Lathrop and James R. Nall, of the Army's Diamond Ordnance Fuze Laboratories.

The prediction from the Laboratories is that application of the process will allow from 1,000 to 1,400 separate electronic components to be packed into a cubic inch, compared with about 100 under present techniques.

Printed-circuit transistors require less power to operate. A satellite thus equipped could either use smaller batteries or could transmit messages for a longer period of time.

VOICE VIA INFRARED

Under test at the Electronic Proving Ground in Arizona is a device capable of transmitting voice over an infrared light wave. The system, which has line-of-sight characteristics, feeds radio or wire messages into the infrared transmitter electrically. The output at the receiving end can be fed into a radio transmitter or a telephone line. The infrared rays, which

(*Continued on p. 1029*)

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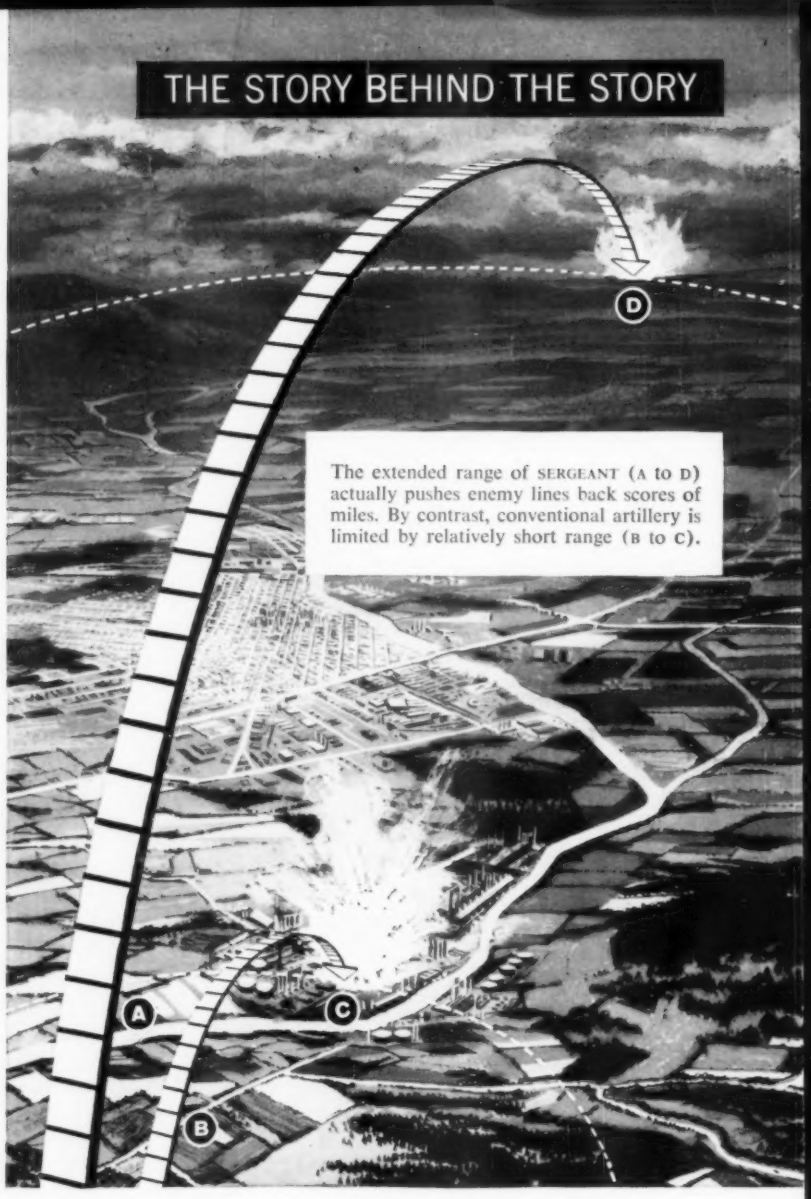
In recent successful test shot, SERGEANT roars into sky. A ballistic guided missile, SERGEANT is guided for precision flight to target. New guidance system cannot be detected in operation.



The extended range of SERGEANT (A to D) actually pushes enemy lines back scores of miles. By contrast, conventional artillery is limited by relatively short range (B to C).

NEW SERGEANT MISSILE WILL GIVE U.S. ARMY GREATER STRIKING POWER

Development of the new SERGEANT ballistic guided missile is a timely reminder that our nation's security requires accurate, highly mobile tactical weapons for ground defense as well as the more spectacular intercontinental missiles so much in the news. In limited or global war, our frontline troops need the support of such a weapon to crush an aggressor's attack long before he comes within the limited range of present artillery.

The SERGEANT missile is the answer . . . a ready-to-go solid propellant weapon with the ability to carry a nuclear warhead, a truly important contribution to the security and retaliatory power of our ground forces. In defense, the powerful SERGEANT will furnish U. S. Army commanders with mobile firepower that will be ready in minutes to strike at any attacking force. On offense, this highly accurate weapon can join tactical air units in destroying enemy fortifications.

The SERGEANT is being developed by the Jet Propulsion Laboratory of the California Institute of Technology for the Army. In preparation for production, Sperry has been working with JPL since the beginning stages of design and development. Complete production of the weapon system will be carried out by Sperry's Surface Armament Division.

Sperry's many contributions to the U.S. missile program, ranging from complete missiles to major sub-systems such as radars, automatic inertial guidance systems, electronic countermeasures, and automatic missile checkout systems, account for its selection as system manager for the production of SERGEANT.

SPERRY GYROSCOPE COMPANY
Great Neck, New York
DIVISION OF SPERRY RAND CORPORATION

are invisible under normal conditions, can be picked up and passed on by relay stations on hilltops to extend the range of the system.

B-52G BOMBER

The new Air Force B-52G, scheduled for delivery this summer by Boeing Airplane Company, will be the first heavy bomber to act as a launching platform for supersonic guided missiles.

A new fuel system and new type engines will enable the advanced B-52G to fly at sustained speeds in excess of 650 miles an hour at altitudes above 50,000 feet. Range of the bomber is expected to surpass 6,000 miles.

FOLDING "JEEP"

A British firm has designed a 700-pound, four-seater, jeep-type vehicle, called the Harrier, that folds into a neat box 9 feet long which can be parachuted from an aircraft. Successful and extensive

British folding jeep.

trials have been carried out on the prototype.

The Harrier is an open car powered by a 650-cc. BSA twin cylinder rear-mounted engine. The folded vehicle can be manhandled by its crew of four without the use of tackle, and it can be made ready for use by them in one minute. Maximum speed is slightly more than 60 miles an hour.

SPIRAL-WRAP CASE

The Army Ordnance Corps has developed a steel spiral-wrap 105-mm. cartridge case that is expected to save one-third the cost of shell-case manufacture. The newly designed spiral-wrap case can be produced for about $1.50, as compared with the average $2.25 cost of cases made by the conventional drawn-case process.

The new case is assembled from three steel pieces consisting of a forged base and a spirally wrapped body held together by a stamped collar. The body is made by rolling a preformed trapezoid-shaped steel sheet in the same way a sheet of paper is rolled to form a hollow cylinder. All parts are made of standard commercial grade steels that are nonstrategic and readily obtainable in wartime, and the design greatly reduces the amount of equipment

CORROSION-PROOF PROTECTION WITH CLEVELAND CONTAINERS

Illustrated are telescope containers used by Cleveland Rock Drill Plant, Le Roi Division, Westinghouse Air Brake Co., and spare parts they manufacture.

These high grade precision parts are assured of protection from rust and corrosion by use of Cleveland Containers with liners treated with VPI (vapor phase inhibitor), a new and highly effective corrosive barrier.

Parts are clean and ready for use when removed from the package. The necessity of a heavy coat of grease or oil is eliminated. Parts may be removed from, or replaced in the original container with no loss of effectiveness of the VPI.

Containers, of 2-piece construction as shown above, can be used to package parts in various lengths. Of quality fibreboard with metal ends, they also provide protection from damage in handling, shipping and storage. Can be labeled with pre-printed wrappers, direct printing or plain color wraps.

Effective and economical, these Cleveland Containers are ideal for packaging spare parts, precision instruments and other articles requiring protection from rust and corrosion.

* * *

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A missile is readied. Will it leap to its target? Or will it fail? In this moment of truth there can be no margin for error, either in the missile or in the preflight system that checks it out. That's why Beckman checkout systems are as infallible as man can make them.

The story of Beckman reliability is best told through Beckman-designed and manufactured industrial systems and sub-systems. Through Beckman solid-state circuitry and electromechanical designs proved in thousands of field applications. Through Beckman counters, timers and frequency meters used as standards the world over. Through Beckman all-transistor data processors and magnetic-core automation controllers at work around the clock in process, steel, paper and aviation industries.

For automatic preflight checkout of missiles or aircraft – wherever malfunction of electrical, control, power supply, hydraulic or pneumatic systems is critical – look to a Beckman system for proven reliability.

Beckman preflight checkout systems *are available now at moderate cost. For more information, or for a consultation with a Beckman systems engineer, write to Dept. 3D-15-69.*

Beckman® *Systems Division*
325 N. Muller Ave., Anaheim, Calif.
a division of Beckman Instruments, Inc.

New Developments (Contd.)

needed to manufacture cartridge cases. Besides saving space and equipment, the spiral-wrap production unit can increase the cartridge case production rate by eighty per cent.

21,000,000 WATTS

A new achievement, expected to contribute significantly to the development and perfection of ICBM detection apparatus, was revealed recently by the Department of the Army. Radarlike signals many times more powerful than believed possible previously have been transmitted by the Cornell Aeronautical Laboratory, Buffalo, N. Y., under an Army Ordnance research contract applicable to U. S. Army missile systems. A power peak of 21,000,000 watts, believed to be the largest peak power ever radiated, was reached by use of a special microwave generator.

NEW SUBMARINES

The GRAYBACK, the Navy's first submarine built expressly for guided missiles, was commissioned at Mare Island Naval Shipyard, Calif., in March.

Armed with the new, long-range Regulus II missile, the GRAYBACK will be capable of launching nuclear attacks against inland targets at distances of more than 1,000 miles. Earlier missile subs have been converted to fire only the Regulus I.

Differing in shape from other fast attack submarines due to twin cylindrical missile hangars on deck, the hull of the GRAYBACK has been streamlined to assure high speeds while submerged. Also extensively fitted for antisubmarine warfare, the GRAYBACK carries a crew of eighty-five.

One naval shipyard and one private yard have been selected to construct the three nuclear-powered fleet ballistic missile (FBM) submarines recently approved by Congress. The Electric Boat Division, General Dynamics Corporation, Groton, Conn., will build two submarines, subject to acceptable contract negotiations, and the Mare Island Naval Shipyard will build one. These submarines are designed specifically for carrying and launching the Polaris missile.

The new submersibles will differ from nuclear-powered submarines now under construction chiefly in their missile features. Their hull configuration, similar to that of the U.S.S. ALBACORE, will give them high underwater speed. They will be equipped with SINS, the Navy's revolutionary new navigation system, and with new stabilizing and electronic equipment incorporating the most recent engineering advances.

MARINE REORGANIZATION

A nuclear-age reorganization of the combat Marine Corps is to be completed by next September 30th. Gen. Randolph

McC. Pate, Marine Corps Commandant, said the changes mean building lighter, faster, more mobile combat units which will be able to travel completely by air, and will be organized and equipped to conduct modern amphibious operations, including vertical assault by helicopter in either nuclear or nonnuclear war.

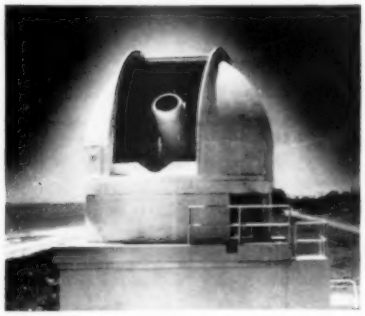
Major changes include the following:

The tank battalion has been cut from the division and transferred to Force Troops. The new division has no tanks. An antitank battalion equipped with the Ontos, a tracked vehicle carrying six 106-mm. recoilless rifles, has been added. Each of these battalions has forty-five Ontos vehicles. The 155-mm. howitzer has been eliminated from the division artillery regiment.

A division reconnaissance battalion has been added. Previously there was a reconnaissance company. The new infantry battalion contains four rifle companies, compared with three rifle companies and a weapons company in the old organization.

LONG-RANGE TRACKER

The Air Force's new Roti tracking telescope, designed and built by the Perkin-Elmer Corporation, Norwalk, Conn., is the most powerful optical missile tracker in use today on the Air Force Missile Test Center Range. It is presently undergoing tests by RCA personnel prior to acceptance by AFMTC.



Roti optical missile tracker.

Roti is used to take high-speed motion pictures of missiles at great distances and provides data which cannot be obtained by any other means. From the photographic record it is possible to determine if scheduled events, such as the dropping of a first-stage rocket, take place properly and on time. Any reaction this might have on the rest of the missile also can be surveyed. Roti has varying focal lengths up to 500 inches, has a 24-inch aperture, and is highly automatic. The complete instrument weighs about 8 tons, and has more than 100 elements in its optical system. It can follow a missile for well over 100 miles.

Every precious bit of telemetered missile data needs a place to come home to, a reduction center full of the most reliable **data reduction equipment** *that experienced systems engineering can produce.*

Whenever a test missile flies, valuable information pertaining to skin temperatures, sub-system flow rates and pressures must be rapidly received and accurately processed. Data must be correlated with real or arbitrary time, and even such fleeting phenomena as liquid fuel levels often must be progressively charted throughout missile flight.

With more than ten years' experience producing dependable, high-accuracy industrial data systems, Beckman is also the first choice of many of the Armed Forces' Prime Missile Contractors. That's why Beckman Data Reduction Systems for *time generation and decoding, data reduction, and propellant utilization measurement* are now at work on many of the Nation's missile ranges, performing on-the-spot data translation and providing immediate digital readout with unparalleled accuracy.

If you would like more information on Beckman field-tested Data Reduction Systems, or if you would like a Beckman Systems Engineer to help you plan your Data Reduction Center, write now for Data File 2D-16-69.

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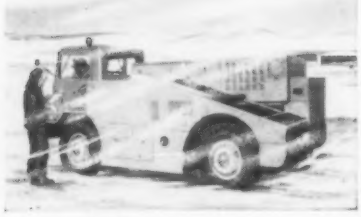
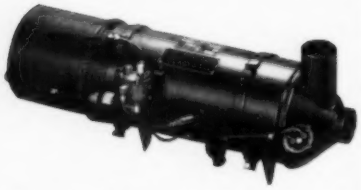
HUNTER ENGINE HEATERS



for military applications at sub-zero temperatures



- designed and produced in accordance with military requirements.
- for starting internal combustion engines at sub-zero temperatures, cold starts to −65°F.
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HEATING AND REFRIGERATION SYSTEMS

ROCKETS AND GUIDED MISSILES

ALFRED J. ZAEHRINGER

Astronautics.—Alpha 1958, the first IGY satellite of the new year and the first for the United States, was placed into orbit on January 31st. The U. S. Army used its tried-and-true Jupiter-C, a modified Redstone missile, for the launching vehicle which consisted of a Redstone for a first stage plus an additional three stages of Jet Propulsion Laboratory solid-propellant rockets.

The first stage developed 83,000 pounds of thrust furnished by the combustion of liquid oxygen and the new hydrazine-based "Hydyne" fuel which provided a performance increase of 12 per cent over conventional alcohol. Over-all length of the 64,000-pound vehicle was 70 feet. The last-stage rocket, 80 inches long, was 6 inches in diameter, weighed 30.8 pounds, and carried a payload of 18.13 pounds of instruments and a transmitter.

On launching, the first stage burned 160 seconds and pushed the vehicle to an altitude of 53 miles and a speed of 6,800 miles an hour. The first stage was then jettisoned, and the vehicle continued to coast upward. Arching over in its trajectory, it was at an altitude of about 220 miles some 400 seconds after launching.

Ignition of the second-stage solid rockets was accomplished by radio. After burning out, the second-stage cluster was dropped, and the third stage was fired automatically. The third stage burned out and dropped off, and the fourth stage finally pushed the satellite to a speed of 18,000 miles an hour. The elliptical orbit reaches out 1,600 miles into space, and its closest point to the earth is about 220 miles.

Preliminary data indicate that the satellite may orbit from 2 to 12 years. The high-power batteries gave out in a few weeks but the lower-power batteries should last about 3 months. Although the external skin temperature of the satellite varies from minus 148 to plus 572 degrees Fahrenheit, the internal temperature of the insulated nose cone is a more comfortable 32 to 86 degrees. However, the intensity of cosmic rays is nearly 12 times greater than on the surface. The severity of impacts of micrometeorites is low.

A second army satellite, Explorer II, was launched on March 5th, but failed to orbit. A second Vanguard launching also ended in failure when, nearly a minute after take-off, the rocket engine gimbaled too far to the right, and the entire rocket was destroyed by the range safety officer. A few weeks later, a third Vanguard launching was postponed because of difficulties in the second stage. A Vanguard and another Explorer have since been launched successfully.

The first meeting of NACA's Space Technology Committee was held recently and resulted in the formation of groups working in specific areas of space-flight problems: objectives, vehicles, reëntry, range, launch and tracking, instrumentation, communication and navigation, space surveillance, and human factors.

Aërodynamics.—With the development of a rocket aircraft, the X-15, well under way, the science of aërodynamics is already pushing beyond present frontiers. The X-15, it is to be remembered, is designed to reach an altitude of 200 to 300 miles and a speed of Mach 5 to 7.

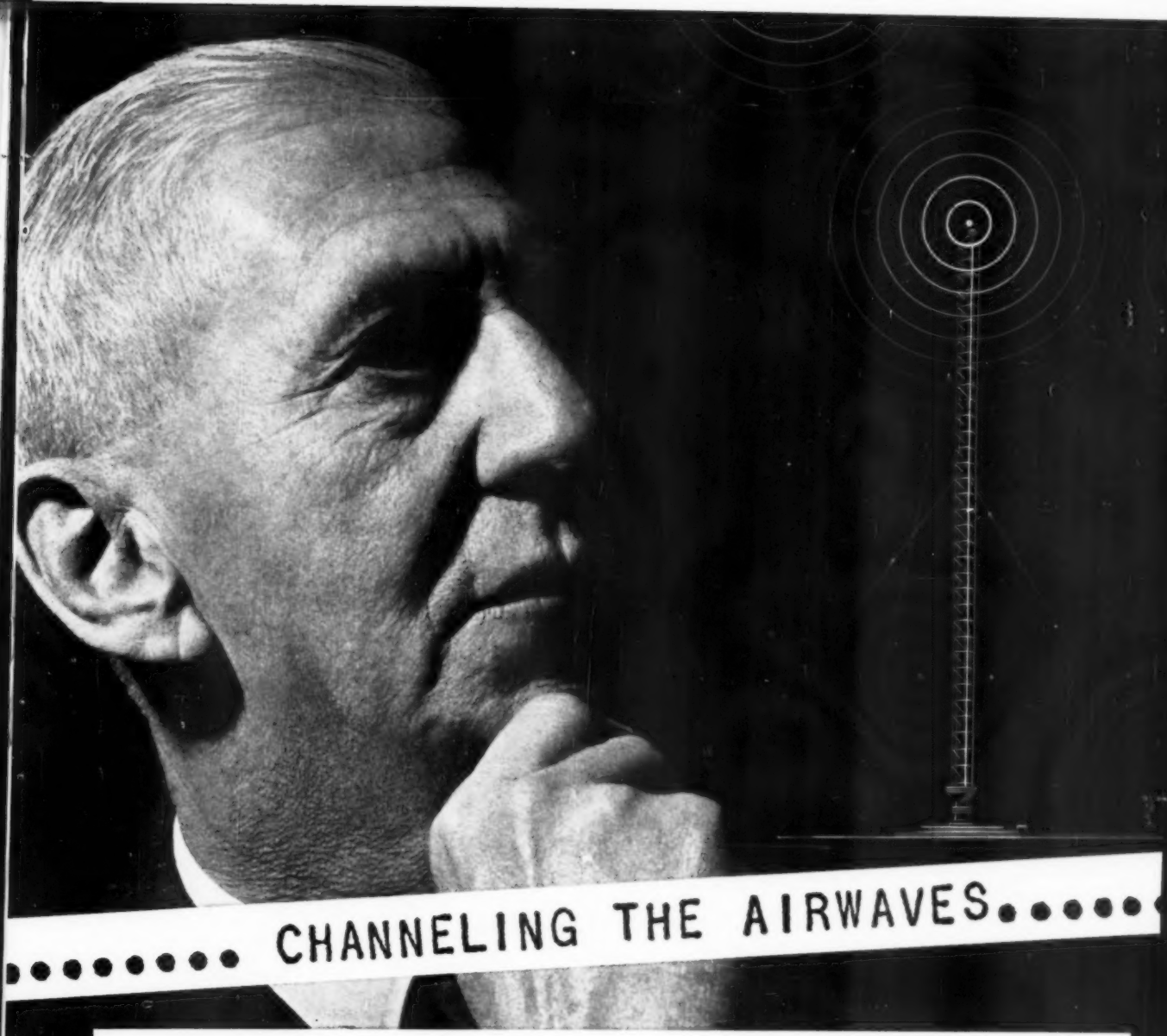
The Air Force has just achieved Mach 50—a speed of 32,400 miles an hour—in its Hotshot II electric-arc "wind tunnel" at Arnold Engineering Development Center, Tullahoma, Tenn. This speed is greater than that required to escape the gravitational field of the earth (some seven miles a second). The short-duration runs, lasting 0.1-second, are used to test missile nose cones.

Another such tunnel using an electric arc is under construction by Lockheed Aircraft Corporation at Palo Alto, Calif. The tunnel is designed to produce a speed of 15,000 miles an hour and temperatures of 18,000 degrees Fahrenheit. The rush of hot gas is produced by an explosion of compressed air triggered by an electric charge of 20 million kilowatts.

Six more electric-arc tunnels are in operation at the Philadelphia laboratories of General Electric Company. Such arcs also are used to test missile nose sections. It was pointed out that one problem—the very different composition of the gas used in the tunnel as compared with regular air—has been solved. Now a plasma of nitrogen and oxygen atoms, ions, and free radicals can closely resemble the required conditions.

In addition to the conventional view of a highly streamlined hypersonic, winged glider for atmosphere reëntry, spheres and hemispheres without wings are being proposed by NACA scientists. Such spher-

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.



CHANNELING THE AIRWAVES

A project of Colonel Edward A. Allen (USA Ret.)
Senior Staff Engineer, Stavid Engineering, Inc.

In 37 years of military service, Colonel Allen has contributed greatly to the evaluation and development of all types of communications equipment for the Army Signal Corps. Currently assigned to Project Monmouth III, Colonel Allen serves on a board to resolve communications and spectrum interference problems associated with the modern dispersed field army. Like other outstanding scientists and engineers at Stavid, Colonel Allen is working on advanced concepts . . . years ahead of actual systems development.

In Stavid's objective engineering atmosphere, scientific, development and manufacturing teams are producing a wide range of electronic systems for the Services. A current project, for example, calls for the development and manufacture of the Mark 70 Gun Fire Control System.

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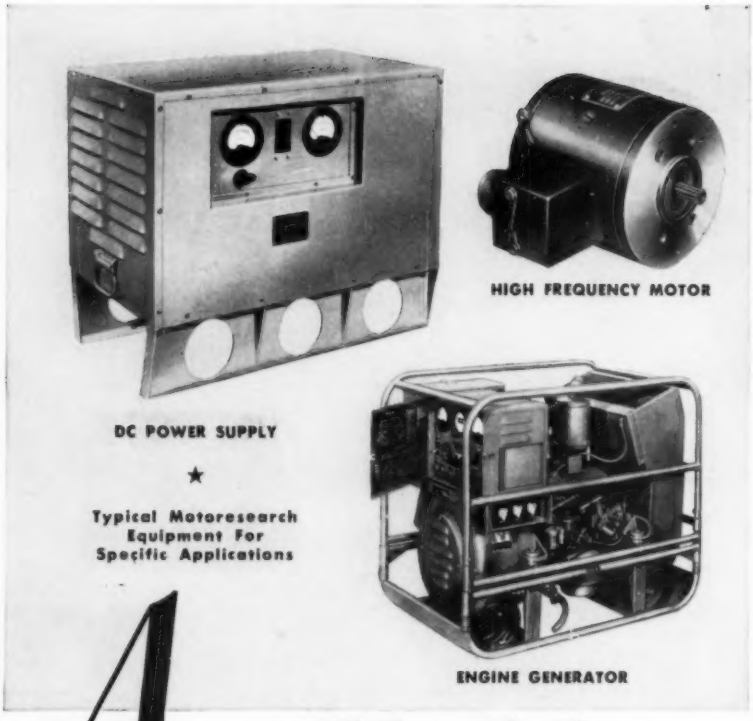

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ical vehicles produce no lift but can safely dip into the atmosphere because of the blunt shape which would dissipate the heat. Drag would slow the vehicle to a point where a near-vertical plunge could take place. At about 30,000 feet altitude, a parachute could safely lower the sphere to the surface. Such a technique, in combination with rocket motors for braking, could conceivably be a method which would enable man to return safely from a satellite orbit.

Propulsion.—Solid-propellant rockets continue to make headway toward larger and more effective weapons systems. Development of the Navy fleet ballistic weapon, Polaris, a 1,500-mile-range IRBM, appears to be successfully under way. The ready-to-go-at-all-times feature and the low maintenance characteristics of solids were recognized by the Army and incorporated into the Nike-Hercules surface-to-air antiaircraft missile and the Nike-Zeus antimissile missile. Next came the replacement of the liquid-fueled Corporal by the solid-fueled Sergeant with a range of 75 to 100 miles. More recently, the solid-fueled Pershing was announced as a replacement for the Redstone missile. Pershing will be much smaller than Redstone and yet have a range capability stated to be 200 to 500 miles. A solid IRBM is destined to replace the Jupiter and Thor. Just recently, the Air Force announced that it would develop a solid ICBM to be called the Minuteman.

It is believed that these solid-fueled missiles are not far off since one producer stated that the firing of a single solid engine with over ten tons of propellant already had taken place. In addition, to scale-up, solids are expected to score new performance gains by incorporation of boron fuels in the propellant.

Meanwhile, liquid rockets continue to advance. Largest U. S. liquid rocket engine is reported to produce 165,000 pounds of thrust. Clustering these engines could give higher powers. The Air Force has announced that it is undertaking the development of a single rocket engine capable of delivering 1,000,000 pounds of thrust. Manifolding techniques would permit thrusts of 1,500,000 pounds.

Our atomic rocket engine program appears headed for increased activity. The Atomic Energy Commission is to ask Congress for additional funds to speed up atomic rocket developments. Dubbed "Project Rover," first firing of an atomic rocket is slated to take place later this year at AEC's Watertown, Nev., test site. Development work has been under way at the Los Alamos and Livermore laboratories and at the University of California. Joining this group will be North American Aviation, Inc., which was awarded a research and study contract for the atomic rocket engine by the Air Force.

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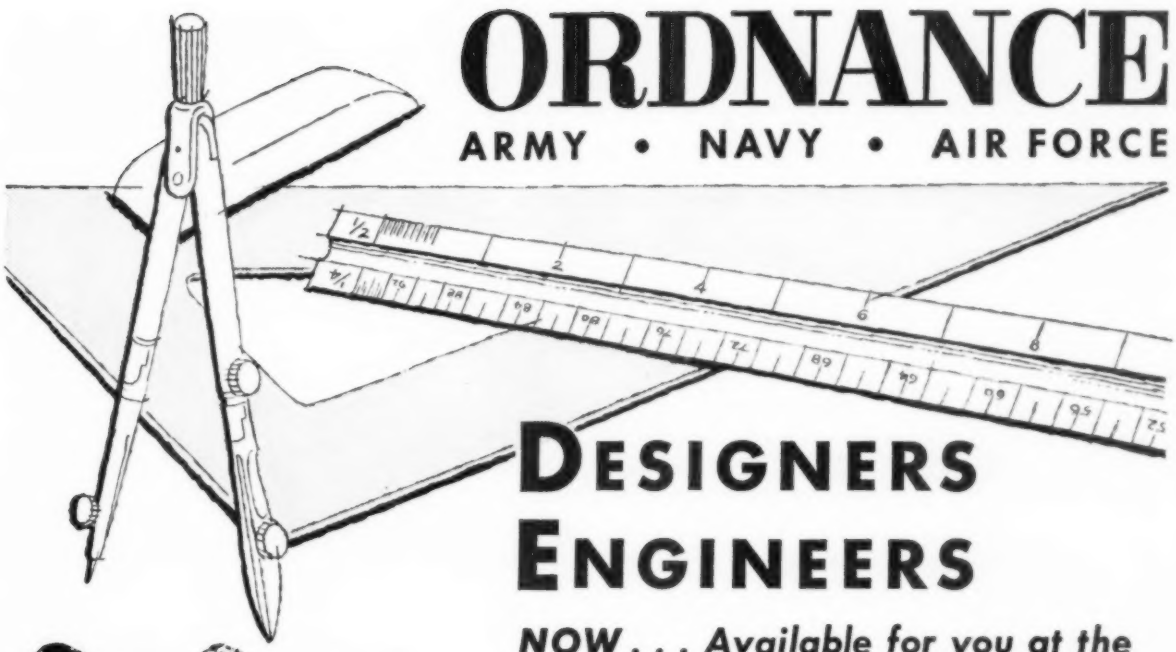

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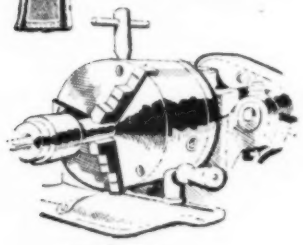

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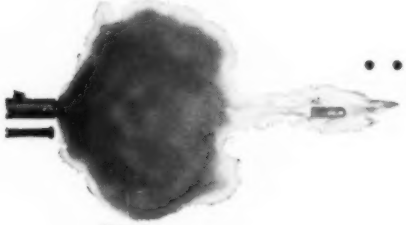

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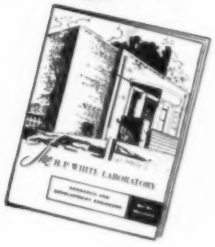

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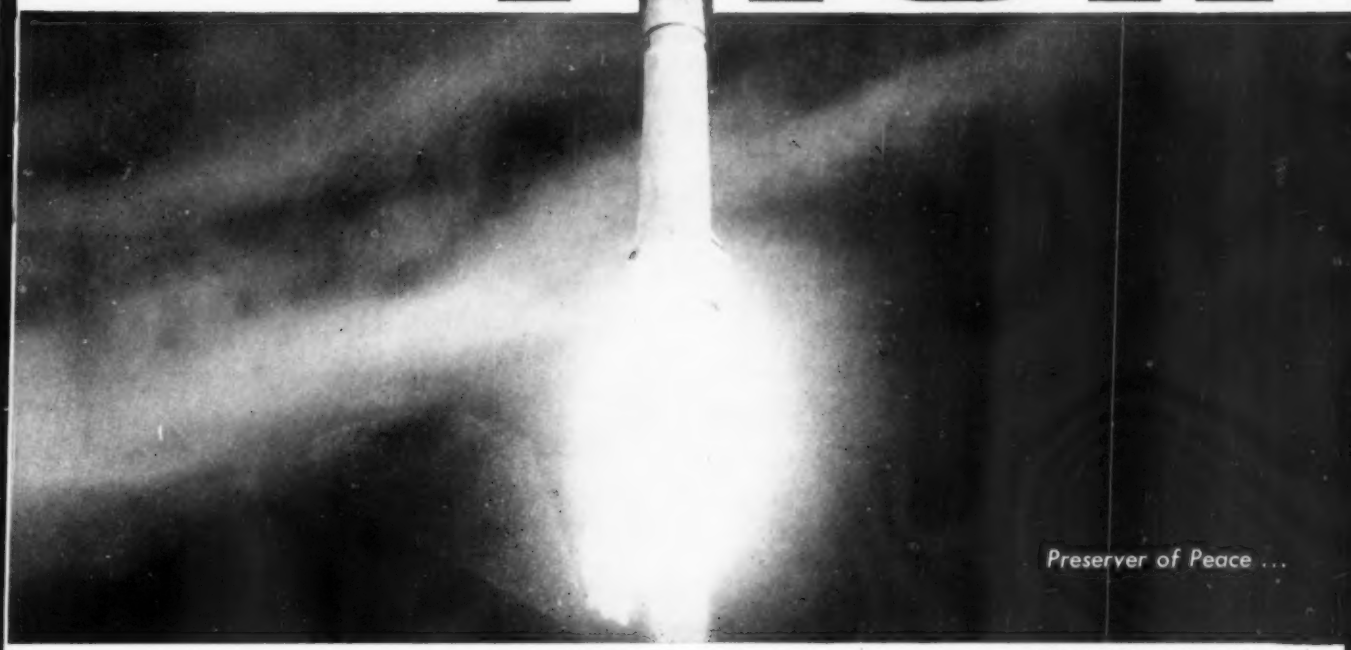

Official U.S. Air Force Photo

The very heavens shake with the thunder of some 135,000 horses as Thor streaks across the sky at 10 times the speed of sound. Designed by Douglas Aircraft to deliver total destruction to targets as far away as 1,500 miles, Thor represents the Air Force's striking arm where ground objectives are concerned. For this surface-to-surface intermediate range ballistic missile, with its inertial guidance system, RCA has developed and is supplying electronic units to help Thor declare its mission: the prevention of war.

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A Down-To-Earth Look At Today's Missile Picture

NOW that operational missiles are becoming a reality and production in quantity a fact, it has been necessary to look at the tremendous storage, transportation, and ground handling problems from a practical, dollar-conscious, down-to-earth point of view.

Each day more assignments for the development and manufacture of *practical, economical* handling units are being brought to Fruehauf, long known for its expert experience and education in commercial transportation areas. And Fruehauf has successfully responded in filling the need for the design and manufacture—at lowest possible cost—of dependable, versatile, multi-purpose ground handling units in quantity —on practically a commercial level. This is the business like approach to the missiles picture, but it must be made, and no one is better equipped and staffed than Fruehauf to do so.

Not only in relation to missiles but for *many* military ground-handling needs, Fruehauf research, engineering, and manufacturing knowledge is being utilized profitably by the services and other contractors. Here are a few of the widely varied projects with which Fruehauf has been associated in a development or manufacturing capacity:

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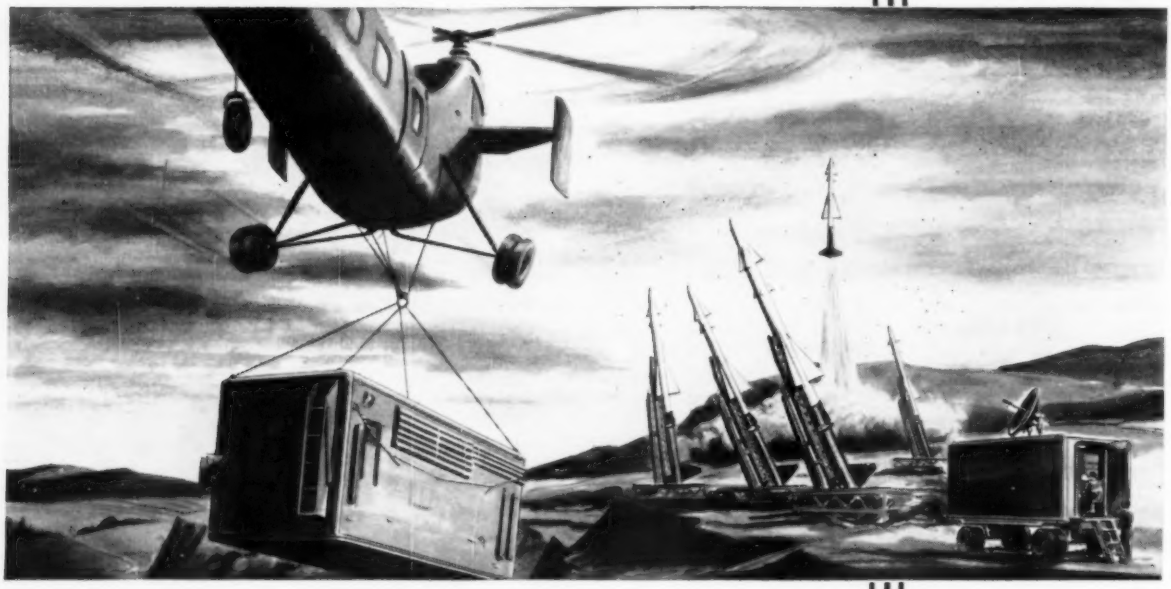
- **Formal detail specification drawings in quantity**
- **Rough terrain trailers**
- **A total of over 400 different types of military vehicles**

You can put confidence in Fruehauf's long experience and extensive facilities in meeting any ground handling problem concerning missiles, guidance shelters, weapons systems, or materials supply.



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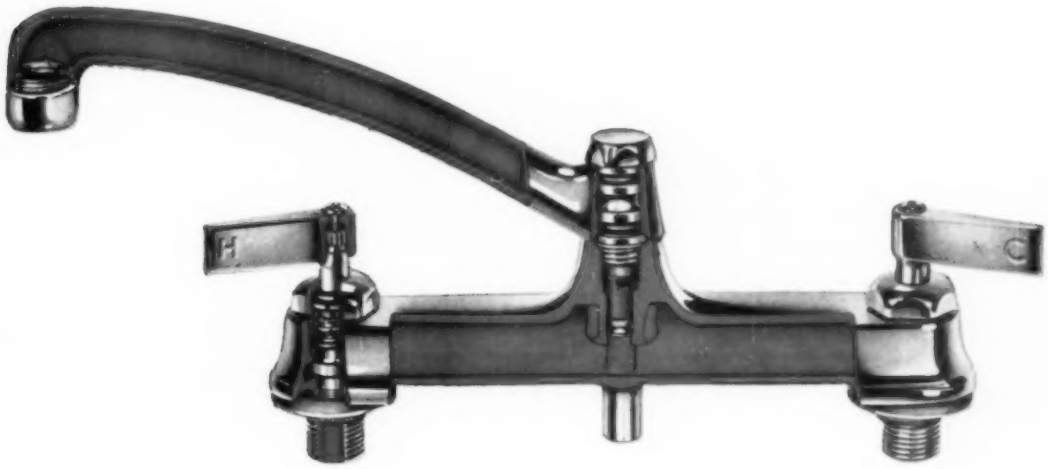

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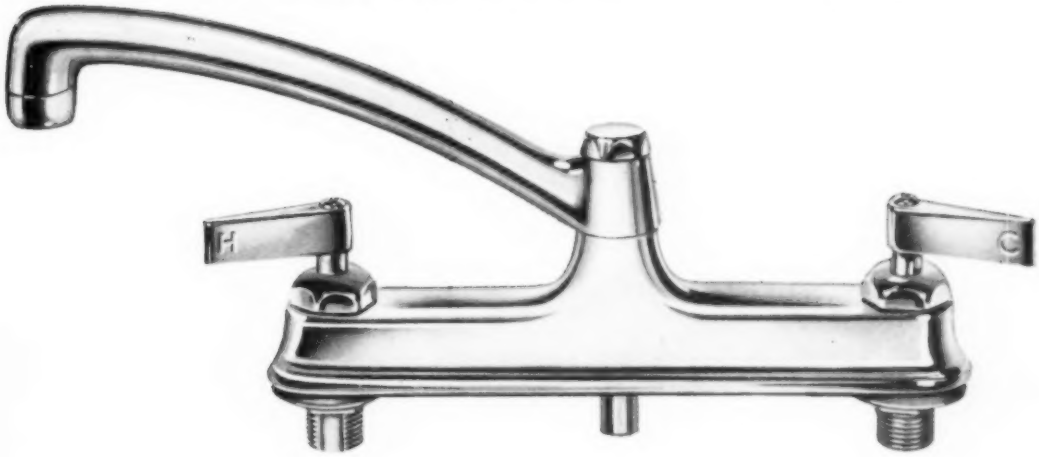

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W. H. Van Vliet

Automatic Flight Control System.—The Air Matériel Command recently announced the award of a $2.6 million research, development, and flight-test contract to provide an automatic flight-control system which utilizes thrust reverse and permits automatic or instrument landings by high-speed aircraft. North American Aviation, Inc., will operate as a systems manager to conduct an analytical study and determination of what is required in developing an automatic instrument landing system (ALIS) which will take over controls from the pilot.

Present instrument landing systems are primarily manual and were designed for older type, low-speed, propeller-driven aircraft which required a fixed low-angle glide path.

The ALIS, under terms of the contract, proposes multiple and variable glide paths with constant speed control. The system will include manual operation and will allow the pilot to override the automatic control. The contract also provides for design, fabrication, and installation of the system in an F-100 Super Sabre.

Airborne Early Warning.—The new Navy WV-2E early-warning aircraft flew recently for the first time with the world's biggest airborne antenna and most powerful aërial radar. This potent, new airborne early-warning combination, developed by Lockheed Aircraft Corporation under Bureau of Aëronautics sponsorship, is expected to see half again as far as any present aircraft radar and will reduce "sea clutter" interference appreciably. Radar coverage from sea level to 100,000-foot altitudes will be provided in a single vertical pulse.

The large antenna is enclosed in a saucer-shaped radome measuring more than thirty feet in diameter and is installed high atop the WV-2E Super Constellation's fuselage. The high-powered radar, designated the APS-70, has been flown before but not in operational use with the giant antenna. Lincoln Laboratories were directly responsible for the basic development of the new radar. The powerful radar unit is produced by General Electric and the antenna system is built by Hughes Aircraft.

B-52 Countermeasures Program.—Sperry Gyroscope Company has been assigned the responsibility by the U. S. Air Force as weapon systems manager for the development and production of electronic countermeasures (ECM) for Strategic Air Command's B-52 bombers. Lieut. Gen. C. S. Irvine, U.S.A.F., Deputy Chief of Staff, Matériel, stated that Sperry was selected for this all-important rôle after a comprehensive facilities and management survey. He said: "The B-52 will be very well protected with a revolutionary form of electronic countermeasures."

Electronic countermeasures, born during World War II when thin strips of metal "chaff" tossed from allied bombers confused enemy radar operators, is known to have advanced rapidly under a tight cloak of security. Research leading to new techniques of miniaturization, packaging, and new components, has created entirely new concepts for the protective "electronic shield," now a prime requirement in modern weapons systems.

Radio Telescope.—The Office of Naval Research and the University of Michigan plan to construct a giant radio telescope that will have the double duty of following the sun by day and spending its nights picking up radio waves from outer space that are only a few centimeters long. The radio telescope will hear signals from the sun, the moon, planets, turbulent gas clouds, "radio stars," and galaxies millions of light years away and from other sources, some possibly beyond the range of the best optical telescope.

The unit uses a dish-shaped reflector eighty-five feet in diameter and about one hundred feet high. It is expected that the signals received will be produced by the interaction of electrons with atomic particles or magnetic fields and will yield data about the originating regions. It is anticipated that this project will be completed sometime next summer.

Automatic Gun Tester.—An automatic electronic gun tester will enable a Navy fighter to check the accuracy of its guns in a few moments without firing them. This tester, developed by Westinghouse under a Bureau of Aëronautics contract,

(*Continued on p. 1043*)

Lieutenant Colonel Van Vliet, formerly director of armament electronics, Northeast Air Command, and formerly chief of the Operations Division, Air Force Ammunition Services, is engineering representative of International Electronics Engineering, Inc., Washington, D. C.

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It is now three years since that belief motivated management's action with the foundation of a program in pure research. Known as the Research Institute of Advanced Study, RIAS is now a substantial organization staffed by scientists who are working in many fields, including theoretical physics, biochemistry, metallurgy and mathematics, without short-range applied research requirements.

Today, the increasing appeals to industry and the nation for accelerated activities in basic research give the RIAS story a special significance. For creative research in pure science is the true life source of our technological security—the "seed bed" from which our national strength shall continue to grow.

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is built into the aircraft as an integral part of its electronic gun-aiming system.

Long-Range Radar.—Lincoln Laboratories recently developed a huge experimental long-range radar to study ballistic missile defense systems and successfully detected the Soviet earth satellites at remote distances. The new radar in operation just north of Boston apparently has tracked Aerobee missiles fired at Fort Churchill, Canada, approximately 1,200 miles away.

An 84-foot-diameter parabolic reflector which can be rotated 360 degrees in azimuth and elevated from horizontal to the zenith is used. The reflector is mounted on a steel tower about ninety feet high. Specially designed klystron tubes about eleven feet high make possible extremely high power transmission. The new radar also will be used to study radio effects of the aurora and meteors.

Scatter by Quadruple Diversity.— General Electric Company is building a long-range sideband tropospheric scatter system for Air Force use in the Arctic. The system will employ "quadruple diversity" to minimize signal loss. Two huge antennas, 150 feet high by 120 feet wide, will be employed for each terminus and will be fed both horizontally and vertically polarized signals simultaneously. A 700-mile single-hop range is expected of the new system which was developed by Lincoln Laboratories.

Integrated Cockpit Display.—A symposium was recently held in Dayton, Ohio, for representatives of Government and industry to discuss Air Force philosophy and concept for integrated cockpit instrumentation and controls. The system generally in acceptance by the Air Force uses a minimum of aircraft instruments and utilizes "human engineering" to ensure as much freedom as possible to the pilot in making decisions and in reducing instrumentation clutter.

Telemetry Survey.—The Army Signal Corps recently announced the award of a contract to Aeronutronic Systems, Inc., to survey the entire field of missile telemetry. This survey will provide a basis for tri-service standardization of telemetering techniques and facilities. The survey will include frequency allocations, bandwidth requirements, transmission rates, types of modulation and circuitry.

Photo Recon Pod.—Fairchild Camera & Instrument Corporation will soon begin production of a photo reconnaissance system pod for the B-58 Hustler jet bomber. A closed-circuit TV in the 65-cubic-foot pod will enable the operator to select photo targets as he views the terrain.

Wolverine Selected to Create and Produce a Ground Support Motor Generator Unit for Convair's F-106A

Under contract for Convair Division of General Dynamics Corporation, this multiple output generator set, created for support of the F-106A, is a typical Wolverine solution to a specific problem in precise power requirements.

This lightweight, portable unit provides power for every electrical component on the F-106A including its highly complex Hughes XXX airborne armament control system.

In addition to the great number of generator sets designed and the many thousands produced for the Air Force, Wolverine has fulfilled numerous similar contracts for the Corps of Engineers, U. S. Navy and many industrial establishments.

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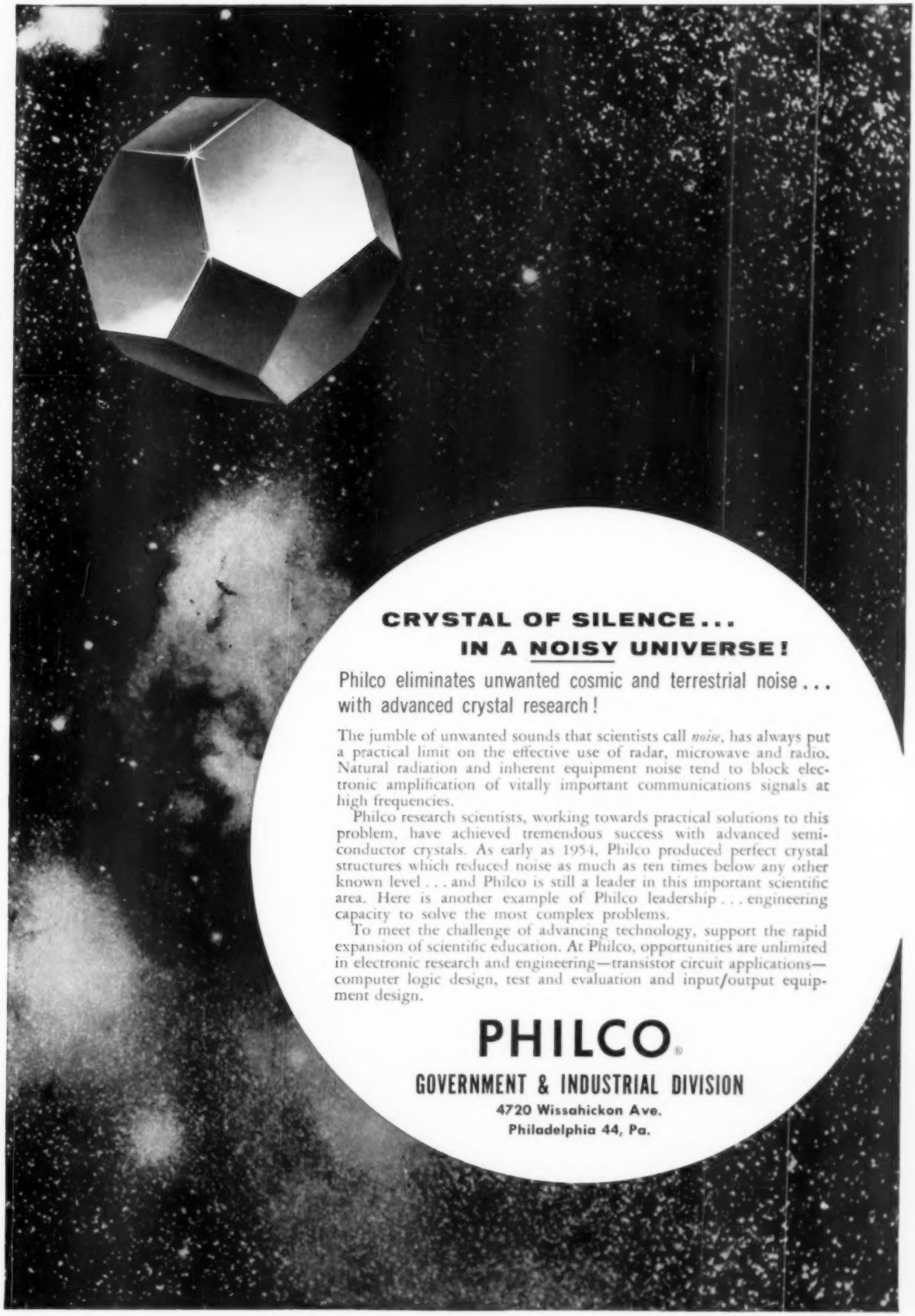

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Navy Yokes	Landing Mat Machines
15" H. C. Projectiles	Fork Lift Trucks
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Tank Turret Redesign

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RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*

Air Base.—*U. S. Patent No. 2,814,453. Issued November 26, 1957, to George S. Trumble, Jr., Richard K. Wentz, and Nickolaus W. Magyar. Assigned to the Martin Co:* This invention provides a means for landing and launching bombing aircraft in relatively rapid sequence in a relatively restricted space. The means for landing the airplane are shown in Figure 1. They consist of a conventional arresting gear 3 such as now used on

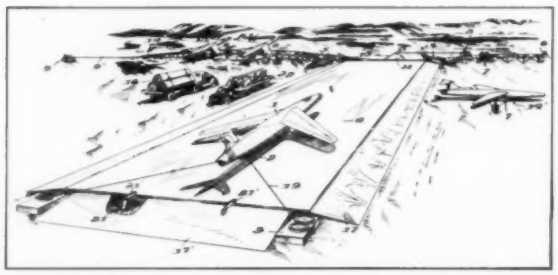

Fig. 1. Arresting gear and resilient landing mat.

aircraft carriers. The aircraft lands directly on its fuselage upon the surface of a resilient mat 4. At the end of the mat is a trackway 5 running to one or more zero-length launchers 6, by means of dollies 7.

Portable winches are used to pull the airplane from the landing mat onto a dolly, and others are used to move the dollies along the trackway. The landing mat may be made up of a number of inflatable mattress sections stacked together. When collapsed, they may be individually rolled up as at 16 for transport on a truck.

Booster Separator.—*U. S. Patent No. 2,809,584. Issued October 15, 1957, to Bernard Smith. Assigned to the Secretary of the Navy:* This patent relates to multistage rockets, and more particularly to apparatus for effecting separation between a rocket booster motor and a forwardly attached rocket propelled by the booster motor. A segmental connector ring is used, the segments being connected by explosive bolts. When any one of the explosive bolts is actuated, the segments separate without applying lateral course deflecting forces to the forward component. This ensures against trajectory disturbances.

Rotating Band.—*U. S. Patent No. 2,809,587. Issued October 15, 1957, to C. Walton Musser. Assigned to the Secretary of the Army:* This invention relates to plastic-reënforced, fin-type rotating bands for rotary or spin-stabilized projectiles. The advantages claimed are: (1) sufficient strength to impart the desired rotation to the projectile, with a reduced force required for engraving purposes; (2) reduced wearing effect on the rifling of the gun caused by the engraving of the rotating band;

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Recent Patents (Contd.)

(3) reduction of the weight of projectiles by permitting a reduction of the wall thickness, thereby increasing the payload of such projectiles.

High-Impulse Fuel.—*U. S. Patent No. 2,811,431. Issued October 29, 1957, to Fritz Zwicky, James M. Carter, and Frederick J. Ewing. Assigned to Aerojet-General Corporation:* This invention provides a liquid propellant capable of generating a high specific impulse in a jet engine at practical temperatures and pressures; *i.e.*, well below 2,600° Kelvin and 300 pounds per square inch. The propellant charge consists of a mixture of 1 mole of acetylene, 2 moles of ammonia, and 1½ moles of oxygen. The reaction is

$$C_2H_2 + 2NH_3 + \tfrac{3}{2}\,O_2 \rightleftarrows 2CO + H_2O + 3H_2 + N_2$$

The available specific impulse from such a mixture is 260 lb. sec./lb. of fuel.

Armored Vest.—*U. S. Patent No. 2,808,588. Issued October 8, 1957, to Ralph W. Persico. Assigned to the Secretary of the Army:* This patent provides an armored vest having an overlapping sectional back. The sections are connected by strips of flexible fabric. The object is to provide maximum maneuverability while maintaining maximum protection.

Cluster Bomb.—*U. S. Patent No. 2,809,583. Issued October 15, 1957, to Roman L. Ortynsky, Seth Q. Kline, and Arvis G. Williams. Assigned to the Secretary of the Army:* This patent provides

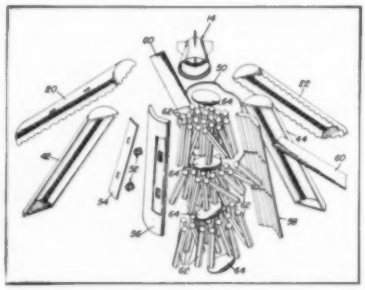

Fig. 2. Bomb parts after detonation.

an airborne-type multipurpose cluster bomb casing which is adapted to receive bombs of different shapes and sizes without requiring any appreciable adaptation of the bomb casing. Figure 2 shows the parts of the bomb in position a moment after it has been detonated.

Liquid Oxygen Explosive.—*U. S. Patent No. 2,812,246. Issued November 5, 1957, to Samuel W. Martin. Assigned to Great Lakes Carbon Corporation:* This patent provides a process for producing an explosive of the liquid-oxygen type with reduced sensitivity to detonation by impact or friction. Liquid oxygen is absorbed in a hard, granular, essentially nonactivated absorbent carbon.

Detonating Cable Weapon.—*U. S. Patent No. 2,812,710. Issued November 12, 1957, to Harry D. Tyson. Assigned to the Secretary of the Army:* This invention provides a detonating cable, consisting of an elongated cord charged with a high explosive and adapted to fragment metal rings threaded on it. It can be quickly and easily laid out in any desired pattern to function as an antipersonnel weapon.

Bomb Director.—*U. S. Patent No. 2,815,170. Issued December 3, 1957, to William H. Newell and Lawrence S. Brown. Assigned to Sperry Rand Corporation:* This invention describes a computer for determining the correct air heading and time of release of a bomb in terms of an aiming point which may be offset by as much as several miles from the target and whose slant range and relative bearing are known or may be determined from the airplane by suitable means.

Jet Fuels.—*U. S. Patent No. 2,815,270. Issued December 3, 1957, to Edgar A. Lawrence and Frank L. von Brecht. Assigned to the Aerojet-General Corporation:* This patent discloses a jet fuel which is capable of supporting its own combustion without the addition of outside oxidizers and yet is relatively insensitive to shock, unlike pure nitromethane.

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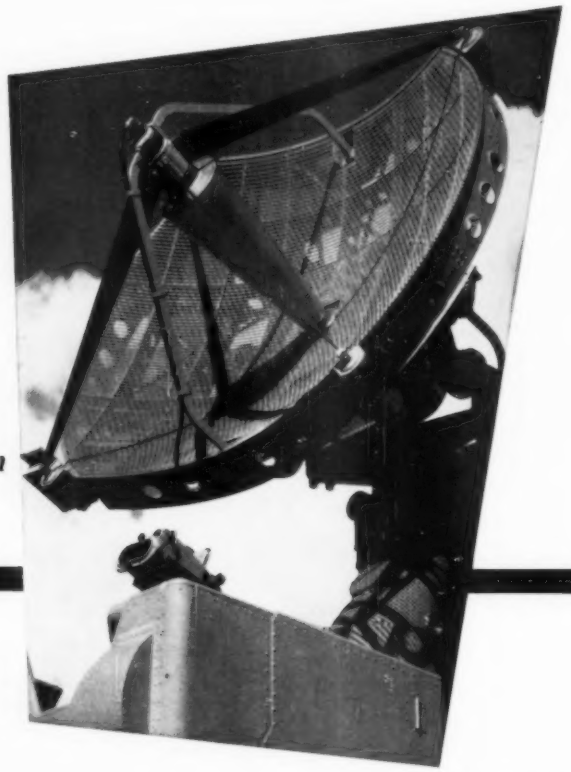

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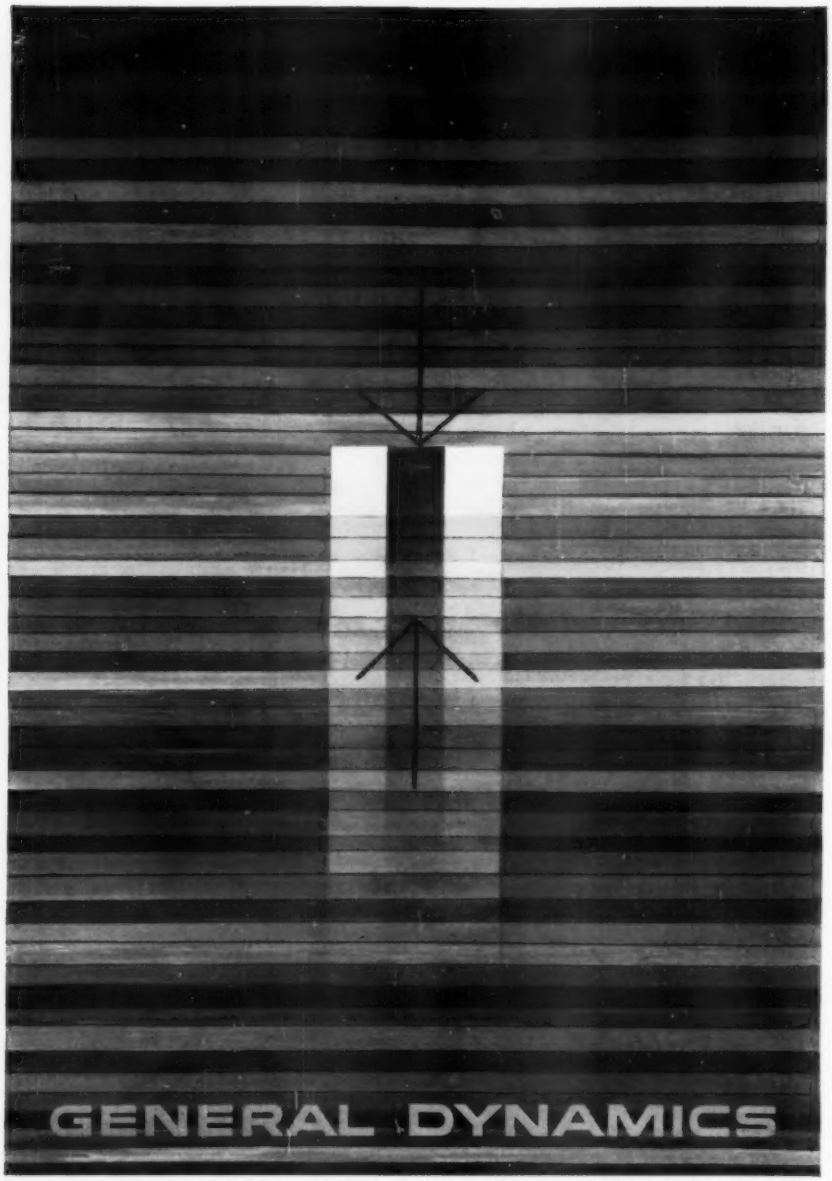

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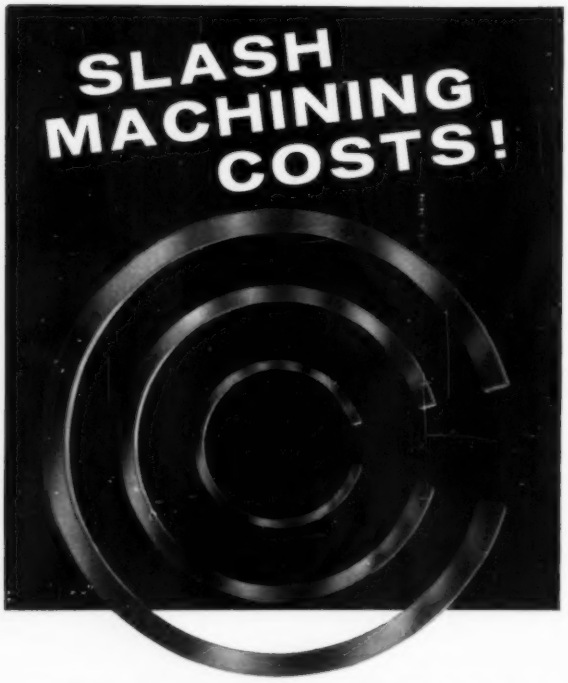

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Book REVIEWS

Reviews in this issue by:

LOREN E. BOLLINGER, *registered professional engineer, Columbus, Ohio.*

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

DR. JAMES B. EDSON, *consultant on electronics, Research and Development Division, Office, Chief of Army Ordnance, Washington, D. C.*

STANLEY L. FALK, *historian, Joint Chiefs of Staff, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

DUNCAN MCDONNELL, *physical scientist, author, Columbus, Ohio.*

COL. CHARLES MCKNIGHT, *U.S.A. (Ret.), ordnance engineer metallurgist, historian, and former company executive, Fork, Md.*

MAJ. GEN. E. P. MECHLING, *ordnance engineer, aircraft armament expert, Washington, D. C.*

JOHN J. O'CONNOR, *educator, author, editor, Washington, D. C.*

Panmunjom: The Story of the Korean Armistice Negotiations. By William H. Vatcher, Jr. New York: Frederick A. Praeger, Inc. 322 pp. $4.75.

THE title to this straightforward and objective history of the bitterly disappointing conclusion of the costly Korean conflict is necessarily dull. This reviewer suggests an alternate subtitle, one which gives the very real value of the book to the thoughtful reader—"An education in Communist tactics and objectives."

Professor Vatcher has done an excellent job in this regard. A study of his recording of the interminable delays and well-nigh incredible nonsense of the Communist negotiators could not fail to be of extreme value to any American who may have to deal with them in the future. Every point—for a defensible line, inspection of prison camps, voluntary repatriation of prisoners, and the rest—was milked dry for its propaganda value to the Reds, as well as for its waste of time (an incredible twenty-four months). Our negotiators were woefully slow to learn, though they caught on to some points and discovered the necessity of bluff.

The author's evaluation of our errors and omissions is splendid, and should do much to make future negotiations less harmful to us and more fruitful to freedom. Simplified, the over-all lesson of the work is that Communism always consists of lies and murder. Its military lesson is: "There is no substitute for victory!"—F. W. FOSTER GLEASON.

The Civil War. A Soldier's View. Edited by Jay Luvaas from the writings and lectures of Col. G. F. R. Henderson. Chicago: University of Chicago Press. 323 pp. $6.

MOST of the present flood of books on the Civil War is of a popular nature of no great value for military study. This book, by a teacher of history at Allegheny College, is based on the works of a British officer who made an intimate study of the American methods just after the war, which included visits

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to the battlefields and talks with officers who fought on both sides.

As a foreigner, the author has given a critical detached analysis of why the North with its greatly superior equipment and overwhelming manpower suffered defeat after defeat from the comparatively weak South for the first three years of the war. He makes it clear that there was no lack of courage or willingness to fight on the part of the Northern soldier but that the fault lay in the politically directed leadership.

When the Civil War broke out, the United States Army totaled 18,000 officers and men. One-fifth of the West Point graduates went with the Confederacy. Jefferson Davis was a West Pointer and, realizing the value of the training, he appointed regular officers to responsible command, mostly to at least brigadier rank where they were immediately available to command and train raw troops.

But in the North the Volunteer generals with political influence were retained despite constant exhibition of the most glaring incompetency. Regular officers were overlooked, and 600 captains and lieutenants were kept with their companies instead of being used for higher commands and for instruction of recruits, thus exhausting the Confederacy.

The second great Union error was the control of the Army from Washington. An army commander in the field must be subject to the discipline of over-all political policy, but when he is subject to the discipline of tactical decisions made by distant staffs or civilian politicians his ability as a field commander is destroyed.

Hooker was a good general, but he did not have the force of character to contend with political Washington. Grant was of a different breed. When first offered his old commission as a captain he replied in unprintable language. He had little use for the grand schemes of the political generals. When appointed Commander of the Armies he went direct to the President and exacted a promise of noninterference, and it is a legend of the war that, in dispatching Sherman to cut a swath across the Confederacy, he advised him to cut the telegraphic communications to Washington.—GEORGE S. BRADY.

Sourcebook on Atomic Energy (Second Edition). By Samuel Glasstone. Princeton: D. Van Nostrand Company. 614 pp. $4.40.

WHEN the first edition of this detailed and very useful volume appeared in 1950 it was widely praised for its accuracy, scope, and general value. Published under the auspices of the Atomic Energy Commission as a source of basic atomic-energy information for textbook authors and editors, it attracted a much wider readership and was used itself as a textbook as well as a standard reference work for the general reader. Now, brought up to date and enlarged, it should prove even more welcome. Its author is a consultant with the Atomic Energy Commission and has published books on chemistry and related fields.

The book is a veritable encyclopedia of the development and application of atomic science. It begins with the earliest theories of the atom and its structure, describes the growth of thought and knowledge in the field, takes up in turn the study of radioactivity, isotopes, nuclear structure, nuclear fission, and other phenomena, and analyzes the operation of cyclotrons and nuclear reactors for research and for power. New discoveries in research and application are carefully presented. A final chapter deals with radiation hazards, their effects, and the means of controlling them. —STANLEY L. FALK.

Man Unafraid. By Stephen F. Tillman. Washington: Army Times Publishing Company. 228 pp. $4.

THIS is an exciting book and at the same time stimulating to sober thought.

(*Continued on p. 1057*)

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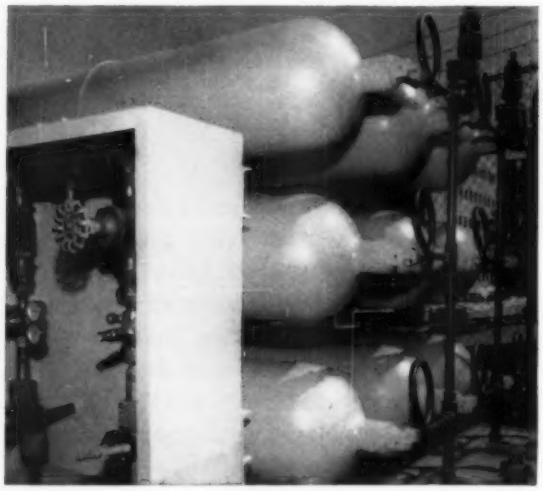

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Another first is a miniaturized version of the Type 314 Halogen Quench Gamma Counter tube, produced by a U.S.Hoffman subsidiary—Anton Electronic Laboratories—in conjunction with University of Iowa physicists. This is the first cosmic ray scout to enter regions where primary cosmic rays can be detected and measured. It is currently circling the earth in the first U.S. Explorer satellite.

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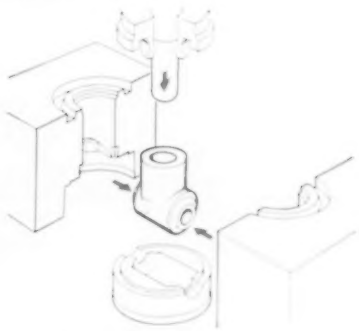

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Book Reviews (Contd.)

The magnificent physical and moral courage of the Wright brothers and our first military fliers is inspiring and at the same time tragic. How could it happen that these volunteers for this hazardous and revolutionary duty should try so hard to succeed and then be treated so badly? On the record it appears that the War Department set up almost every possible obstacle to the creation of sound air power on a timely basis.

We, today, can solemnly vow that such blindness to needed progress shall not occur again. But are we sure? Advanced thinkers, pioneers for new approaches to national security, still have rough going in the face of their conventional, conservative contemporaries. Stephen Tillman has done well to remind us that these early birds—the eleven who died in crashes and those few who lived and succeeded—gave us the basis for our air power which helped gain victory in two world wars and is today the bulwark of our uneasy peace.—EDWARD P. MECHLING.

A Pictorial History of U. S. Single Shot Martial Pistols. By James M. Kalman and C. Meade Patterson. New York: Charles Scribner's Sons. 112 pp. $22.50.

THIS outstanding graphic display brings together a group of military weapons, the originals of which only the most ardent collector could hope to assemble during many years and through considerable financial investment. Mr. Kalman's skillful watercolor paintings have been faithfully reproduced on heavy, high-quality paper in forty-four plates. For each plate Mr. Patterson has supplied a brief description mentioning features which cannot be discerned from the illustrations. His prefatory remarks give the work an excellent historical perspective.

The book is made up of two major parts: "Primary Pistols," consisting of those actually adopted by the military services, and so-called "Secondary Pistols." The latter comprise firearms purchased in small numbers by the Federal Government, purchased or manufactured by State governments, or merely designed for military use by private manufacturers.

Surely the authors have made a handsome contribution which should stimulate interest in the history of the single-shot pistol.—DUNCAN MCCONNELL.

The Seizure of Political Power. By Feliks Gross. New York: Philosophical Library. 398 pp. $6.

IN this scholarly volume Dr. Gross directs attention to the actions and techniques which have led to the seizure of power, specifically to those which have led to the violent transfer and consolidation of power and to the ways in which peoples have struggled against dictatorship and seized power in their own hands. The focus of the present valuable study is on how power is seized, how an existing government is overthrown, and how revolutions are both planned and executed.

The major part of the book deals with the development of Russian revolutionary strategy and tactics over a period of almost a century. Consideration is also given to the sociological meaning of power, and and a number of revolutions—in Latin America, Germany, Italy, China, Poland, and France—are used for comparative and illustrative purposes.

The volume gives us the necessary historical background for alert and vigilant citizenship in defense of our traditional values and interests.—JOHN J. O'CONNOR.

Kamikaze. By Yasuo Kuwahara and Gordon T. Allred. New York: Ballantine Books, Inc. 187 pp. 35 cents (paperbound).

IN this short book we have the interesting account of the experiences of a Japanese suicide pilot. Telling his story to an American soldier, Yasuo Kuwahara begins his tale at the time when he became the glider champion of Nippon in 1943. After being selected for samurai training by an army representative, Kuwahara received his basic indoctrination at Hiro Air Force Base.

He relates many details of the efforts made to instill "spirit" in the trainees. Outright brutality by the *hancho* (NCO) was part of the training for future samurai. Next he went to flying school for six months. Upon entering fighter training the men were accorded somewhat greater courtesy.

In October 1944 the first special group of Japanese suicide pilots was formed, and these kamikazes inflicted the heaviest losses in the history of the United States Navy.

As our raids on Japan increased, Kuwahara began to have some doubts, and life began to have more appeal than that of a glorious death. After Hiroshima, he took off on his suicide mission, but obviously he did not complete it or this fascinating personal account would not have been written.—LOREN E. BOLLINGER.

Drama on the Rappahannock. The Fredericksburg Campaign. By Edward J. Stackpole. Harrisburg: Military Service Publishing Company. 297 pp. $4.75.

"TO achieve more than a superficial understanding of the battle of Fredericksburg requires time and patience," says General Stackpole. He then proceeds to shorten time and ease patience with his excellent narrative history of the Fredericksburg campaign, unique topographical information, and adequate maps.

The narrative is picked up at Rector-

(*Continued on p. 1060*)

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Freedom's defense has reached a new frontier—Outer Space. That is why we need new weapons—missiles . . . and men in missile-like planes.

Already America's giant missiles hurtle into space—exploring the new frontier, guarding its ramparts.

And hand-in-glove with missiles are our new manned weapon systems. Compressing years of progress into months, America's military and civilian engineers are jointly pushing our new defenses to completion.

Americans in Outer Space

Today a few chosen pilots are preparing themselves. Donning the new space suits, they sit in altitude chambers, or whirling centrifuges, testing man's reactions to a savage new environment. Their plane, the rocket-powered X-15, is being readied.

The X-15's mission is to take a man into space . . . and to return him to deliver his report. The secrets he brings back will be shared by the Air Force, Navy, and National Advisory Committee for Aeronautics, joint sponsors of the project.

The sinews of space flight

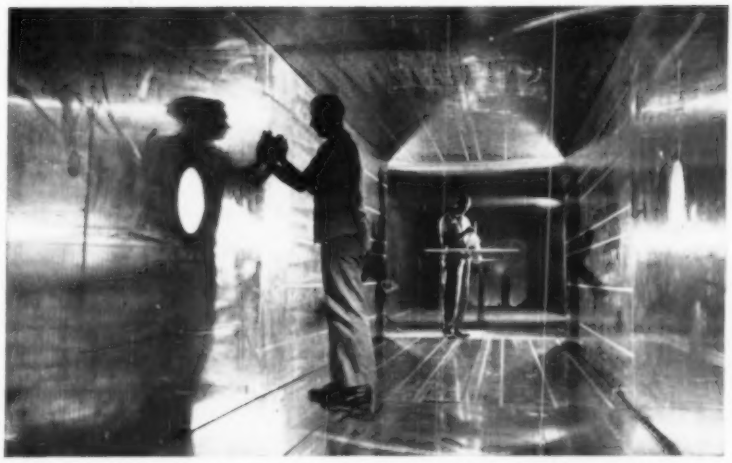
The X-15 is the outgrowth of new technologies developed by North American and its divisions—in guided missiles and supersonic aircraft—in automatic controls and rocket engines. Each is a vital root of the new space flight technology.

NAA's Rocketdyne Division makes rocket engines for the Air Force's Atlas and Thor missiles, and for the Army's Jupiter and Redstone. In fact, every major missile successfully launched in America in 1957 was powered by a Rocketdyne engine.

The Autonetics Division creates automatic control systems for both aircraft and missiles. Only yesterday these tiny fail-proof "brains" were rare technological triumphs. Yet today Autonetics makes them in quantity—with complete reliability.

Weapons—manned or unmanned

Like the Armed Services, North American believes both manned and unmanned weapon systems have their place. NAA's Missile Development Division, backed by 10 years' pioneering missile research, is at work on the GAM-77 advanced air-to-ground missile for the Air Force B-52.



Space Age wind tunnel tests scale models in a 2,500-mile hurricane. It's first of its kind to be built with private funds.

At the Los Angeles Division are two manned weapon systems. The 110A will reach any place on earth at 2200 mph and return to strike another day. The F-108 interceptor's very-long-range radar and atomic missiles will make it lethal to manned bombers and some missiles. It will be a flexible weapon, able to strike at trouble where it starts, before it spreads.

From defense, the arts of peace

North American has not confined its efforts to defense alone. During the past decade it has made great forward strides for the good of all men. The Peaceful Atom, for example, is the field of NAA's Atomics International Division. This division has successfully proved out two nuclear reactors to produce electrical power, both major advances in the drive to put atomic energy to work for mankind.

Today, in North American and its divisions, you'll find as potent a combination of scientists, engineers, and production men as any in American industry. Because they are constantly forging ahead into vital new technologies, their work holds immense promise for science and industry.

Satellite No. 1. A Rocketdyne-built rocket engine gave the Army's Jupiter "C" satellite the critical first-stage boost toward its orbit.

NORTH AMERICAN AVIATION, INC.

SERVING THE NATION'S INTEREST FIRST—THROUGH THESE DIVISIONS

LOS ANGELES — AUTONETICS — MISSILE DEVELOPMENT — ROCKETDYNE — COLUMBUS — ATOMICS INTERNATIONAL

Los Angeles, Canoga Park, Downey, California; Columbus, Ohio; Neosho, Missouri

town, Va., where McClellan had halted in his leisurely pursuit of Lee after the battle of Sharpsburg. It was here Lincoln relieved him of command of the Army of the Potomac in favor of Burnside, a general officer of no great experience or distinction.

From here to the bitter end the campaign, the tragic story of Burnside and the tragic glory of the men of the Army of the Potomac are interwoven. From here they go together to the banks of the Rappahannock which they were prevented from crossing first by Burnside's fear of threatened floods, then by lack of pontons to lay bridges. The very heights they would have occupied became the Confederate stronghold.

At last, three divisions of the army cross the stream to occupy Fredericksburg and the plain to the south. The following day a disconnected and disorganized attack was launched along the ridge line of the Confederate position, culminating in successive massed assaults against the bastion of Marye's Hill, rising steeply from the sunken road and stone wall. Here the attack ended in a bloody repulse with casualties about the same as Lee was later to lose in Pickett's charge.

On the Union side everything and everybody seemed to conspire toward the debacle, and the worst conspirator of all was Burnside. As his was the battle from start to finish, so consequently the responsibility was his and his alone. Luckless Burnside, the affable, obstinate general of imposing appearance and limited intelligence, stumbles from the scene only to meet again with disaster and defeat at the Crater.—CHARLES MCKNIGHT.

On Nuclear Energy. By Donald J. Hughes. Cambridge: Harvard University Press. 263 pp. $4.75.

THIS book was hammered out by the impact, over ten years, of a succession of audiences upon a set of lecture notes. Its author is a professional nuclear research man with a sense for human affairs and a flair for genuine public education.

Nonmathematical, but concise and compact in style, the book presumes and rewards in its readers a certain command and focusing of intellect—a payment of attention. It achieves the rich and vigorous style of good professional works without requiring any previous knowledge of special jargon. It should appeal to the mature nontechnical citizen and to the abler, mentally "hep" high-school student who wants a clear, useful picture of the atomic-energy story.

The first three chapters deal with basic nucleonics. The next three introduce the basic concepts of reactor design and review the use of reactor products—power, neutrons, and isotopes. An unusually varied and up-to-date selection of nuclear applications is described.

Author Hughes was in the original Manhattan Project, remained in nuclear research, is now at Brookhaven National Laboratories. The book is a solid, useful, and up-to-date addition to the growing assortment of "citizens' guidebooks" on atomic energy. It is, in this class, among the best.—JAMES B. EDSON.

Escape of the Amethyst. By C. E. Lucas Phillips. New York: Coward-McCann, Inc. 274 pp. $3.95.

THIS story of a 300-foot British frigate's adventures in Red China is of interest for its account of disciplined courage, but its chief value, perhaps, lies in the lessons to be learned about her tormentors.

Quietly steaming up the Yangtze to assume her authorized station at Nanking, the AMETHYST was fearfully mauled by Red guns, then held at Chinkiang for three months under first trying, then desperate conditions. The account of the negotiations for her release, the unreasoning bluff of bullying braggarts, follows the world pattern of the past decades. But her skipper and crew cut the Gordian knot by running the gauntlet to the safety of Shanghai.—F. W. FOSTER GLEASON.

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Air - Steam - Hydraulic
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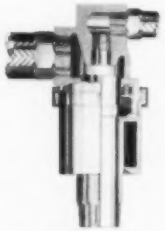
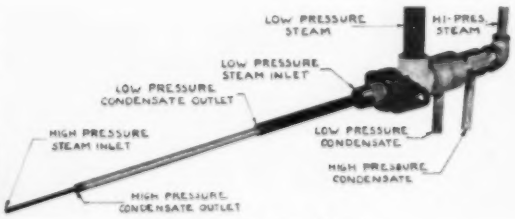
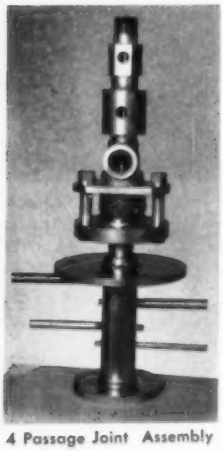


Self Supporting

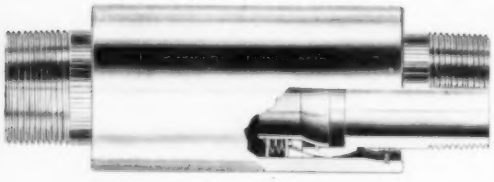
Multiple Passage Joints can be furnished with cavity for Diaelectric Coaxial Cable.



Four Passage Joint #1583



4 Passage Joint Assembly



Rotherm Expansion Joint

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BOOKS RECEIVED

Accounting Guide for Defense Contracts. Second Edition. By Paul M. Trueger. Chicago: Commerce Clearing House, Inc. 464 pp. $12.50.

Basic Training Guide. Fourth Edition. Harrisburg: Military Service Publishing Company. 228 pp. $3.50.

Encyclopaedia of Radio and Television, The. Second Edition. New York: Philosophical Library. 736 pp. $12.

Industrial Control Circuits. By Sidney Platt. New York: John F. Rider Publisher, Inc. 200 pp. $3.90.

New Developments in Army Weapons, Tactics, Organization, and Equipment. By Marvin L. Worley, Jr. Harrisburg: Military Service Publishing Company. 261 pp. $3.50.

Numerical Control Systems for Machine Tools. Proceedings of the EIA Symposium. New York: Engineering Publishers. 106 pp. $5.

Television in Science and Industry. By V. K. Zworykin, E. G. Ramberg, L. E. Flory. New York: John Wiley & Sons, Inc. 300 pp. $10.

Vacuum Tube Rectifiers. By Alexander Schure. New York: John F. Rider Publisher, Inc. 78 pp. $1.50.

advanced

ORDNANCE

30

Research and Engineering at Rheem have been instrumental in developing the new concept of "advanced ordnance"... employing a broad and perceptive approach to the changing requirements in the ordnance field. Current and completed programs include the concept, analysis, development, testing and prototype manufacturing of guided missile warheads/fuzing/mine warfare systems/practice bombs/antipersonnel weapons/ground handling equipment/target rockets. The application of "systems management" to ordnance requirements has yielded integrated ordnance products adapted to current military needs.

Rheem, Downey, California, is a division of world-wide Rheem Manufacturing Company which operates 17 plants in the United States... and with its associated and licensed companies operates 18 plants in 12 countries abroad. These extensive facilities coupled with Rheem's years of ordnance production experience provide the capability for the quantity production of ordnance products and systems.

Engineers: Join Rheem in challenging technical work.

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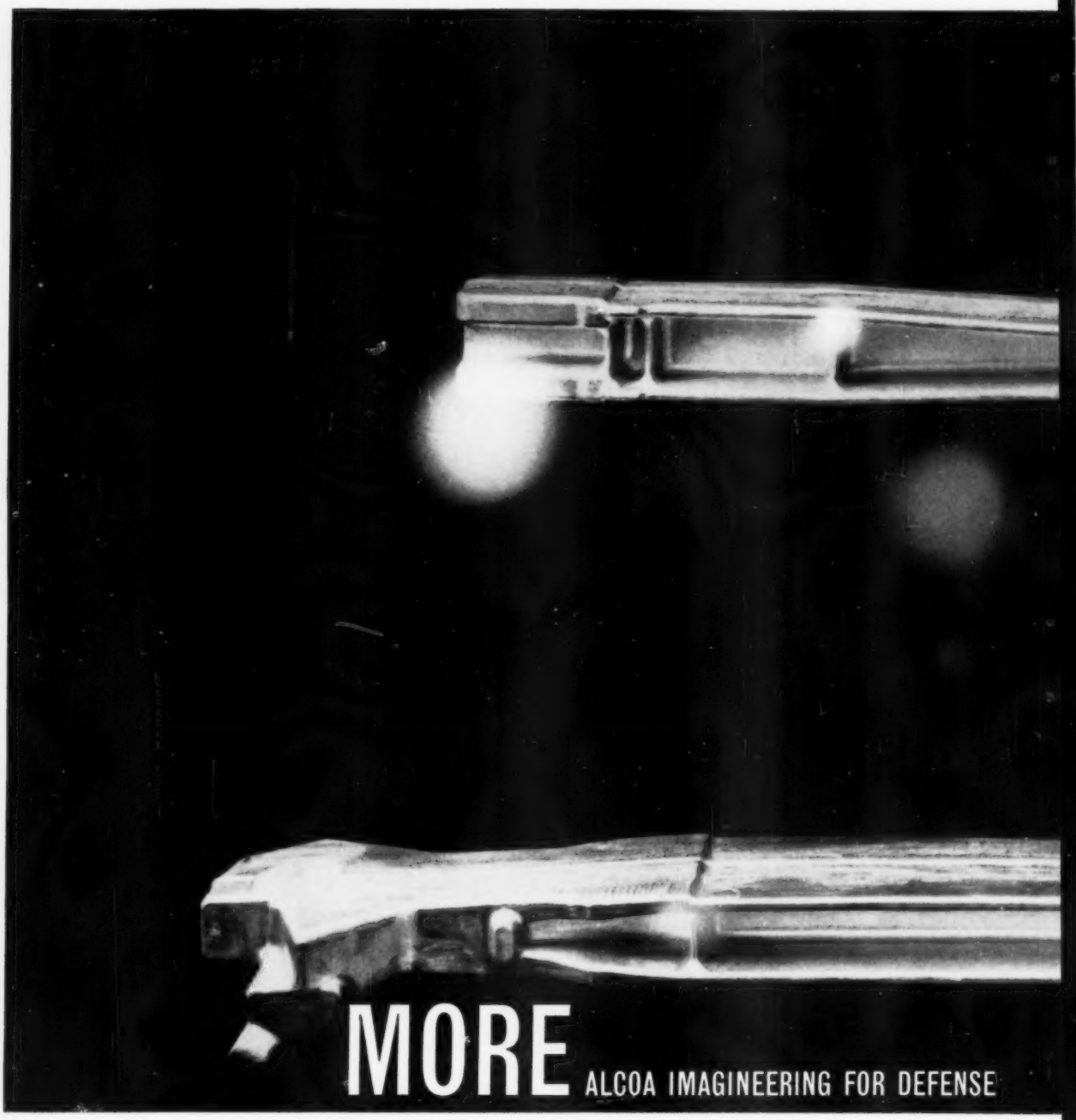

HOW TO FORGE MORE AIRCRAFT DEFENSE PER DOLLAR

Eight of these 230-lb B-52 landing gear bulkheads are now being produced from the aluminum formerly required for one bulkhead. New forging techniques developed by Alcoa are responsible. The new methods cut machining time by 62 per cent, reduce machine tool costs substantially, and save on shipping bulk and costs.

The kind of Alcoa Imagineering which makes these savings possible is always available to you if you specify, design or fabricate for the military.

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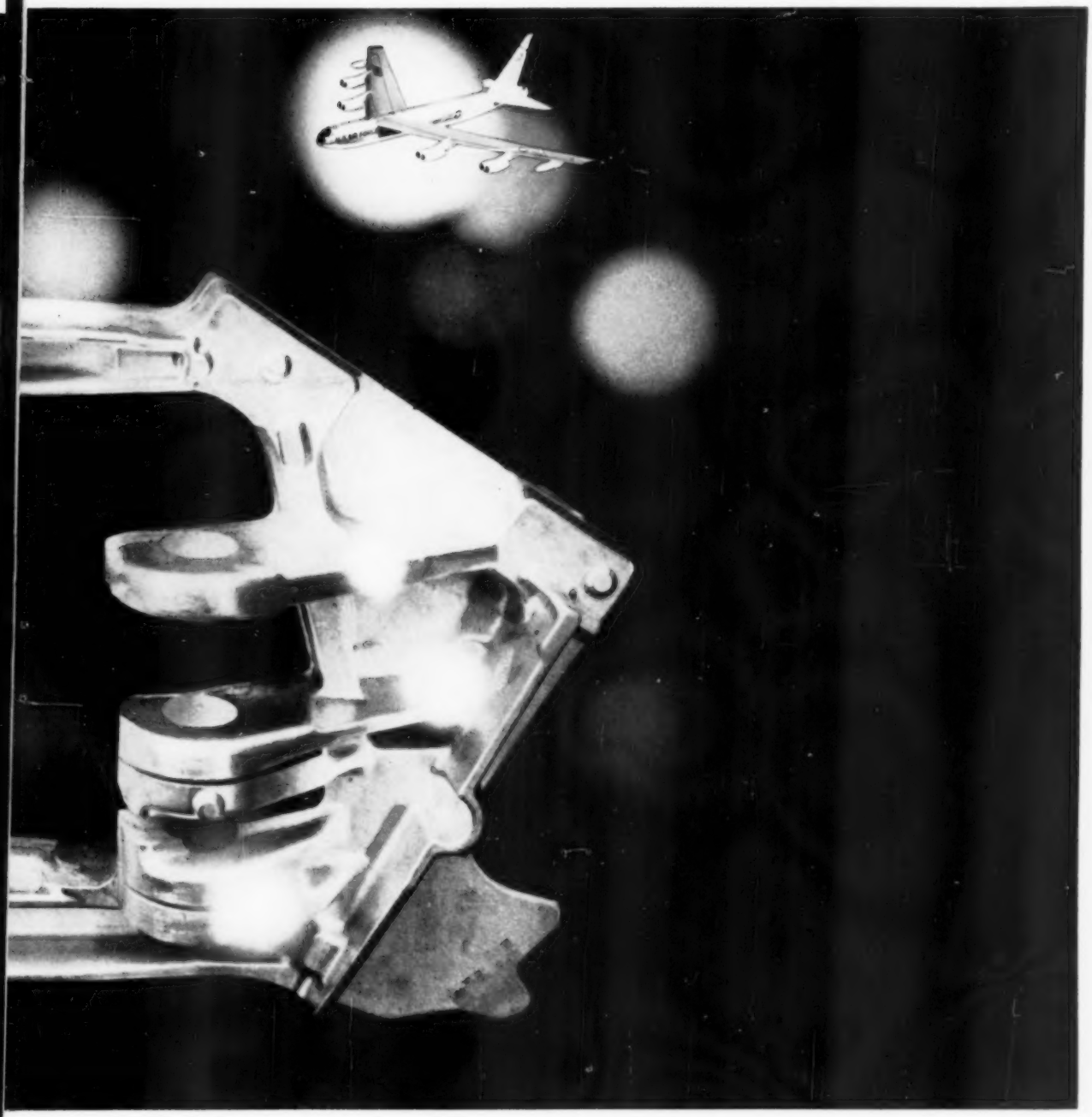

conductivity, low cost, light weight and corrosion resistance—make it ideal for every light-metal application.

It will pay you to talk over your military materiel problems with the most experienced company in aluminum. Contact your nearby Alcoa sales office or write Aluminum Company of America, 850-E Alcoa Building, Pittsburgh 19, Pa.

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Exciting Adventure
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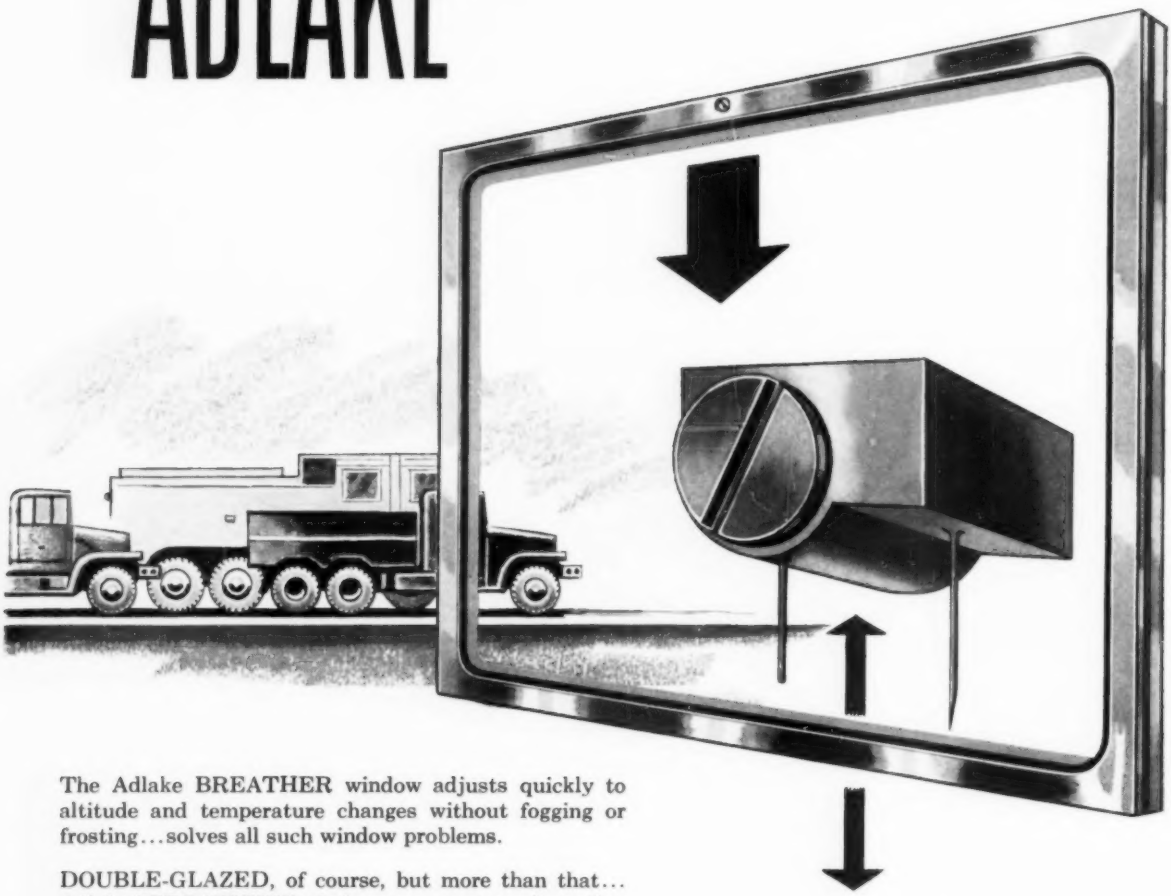
You solve the fog-frost problem

with ADLAKE "Breather" windows



The Adlake BREATHER window adjusts quickly to altitude and temperature changes without fogging or frosting...solves all such window problems.

DOUBLE-GLAZED, of course, but more than that... Adlake "BREATHER" windows overcome condensation problems through effective and permanent sealing of "dead air" between the panes to minimize temperature conductivity. Yet "breathing" through the sash is provided for pressure equalization.

PROVED in more than 150,000 railroad installations, many of which have never needed attention in twenty-five years! And practically all "dome" glazing in railroad scenic cars are Adlake BREATHER types...really maximum exposure, with temperature and altitude changes, and no fog or frost problems whatsoever.

IT WILL PAY YOU to get full information from...or to submit details of your requirements to...The Adams & Westlake Company, 1185 North Michigan, Elkhart, Ind.

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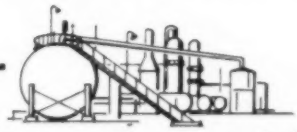
for Liquid Oxygen–



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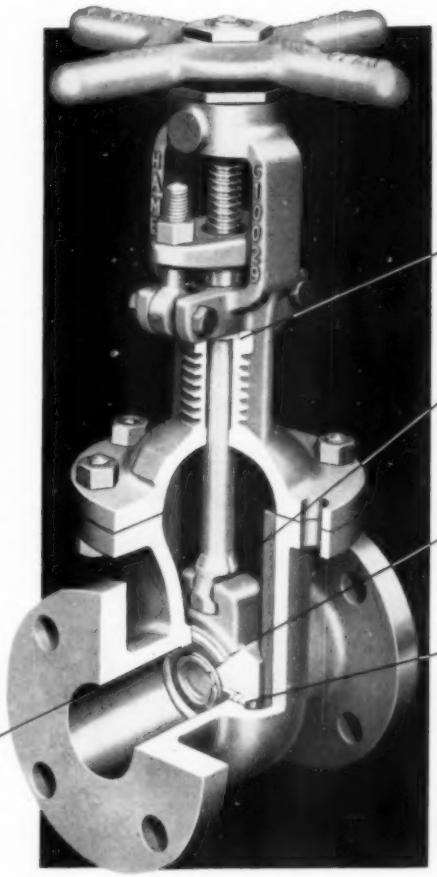
Safe, Vapor-Tight Shut-off of Hard to Handle Liquid Propellants . . .

Proven under actual environmental field conditions, these new Hamer "Vented-Chest" Gate Valves are contour engineered to provide smooth surfaces and clean lines without objectionable cavities where contaminating particles are often encountered. Seal in one side of wedge only vents chest of valve to pipeline eliminating possibility of pressure build up within the valve. Valves seal equally well with line flow in either direction. Air operated models available.



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Chevron Packing is long lasting, sure-sealing, expands as pressure increases to prevent escapage.

Chest Vented to Pipe Line

Seal on one side of the wedge vents chest to pipeline, thus possible locked-in pressure build-up in valve interior is prevented.

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Seating surfaces of the wedge are precision finished to provide an exacting metal-to-metal fit.

Positive Shutoff Seal

Located in one side of the wedge, this seal compresses against valve seat forming an absolute shut off.

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Integral seat in the body eliminates threads, welds, cavities as well as other objectionable surfaces.

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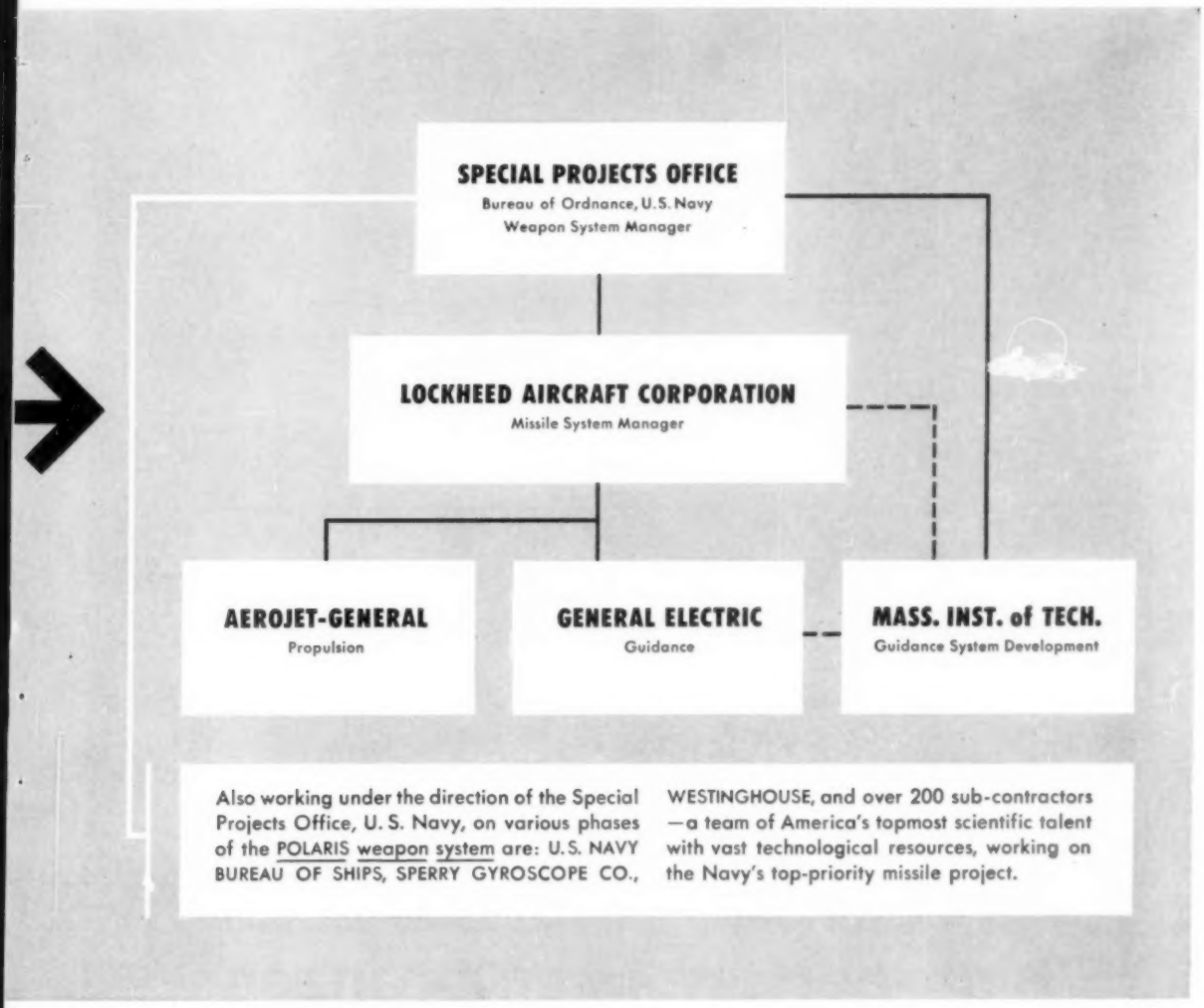
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Also working under the direction of the Special Projects Office, U. S. Navy, on various phases of the POLARIS weapon system are: U.S. NAVY BUREAU OF SHIPS, SPERRY GYROSCOPE CO., WESTINGHOUSE, and over 200 sub-contractors —a team of America's topmost scientific talent with vast technological resources, working on the Navy's top-priority missile project.

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Progress to date on the POLARIS has exceeded all expectations of the U.S. Navy. Lockheed is proud to be associated with its fellow task force members and the sub-contractors developing the complete POLARIS weapon system. The brilliant contributions and splendid teamwork of these more than 200 POLARIS subcontractors, and their dedication to our mutual goal—greater security for our nation—speeds the progress of the POLARIS missile system, prime responsibility for which is Lockheed's.

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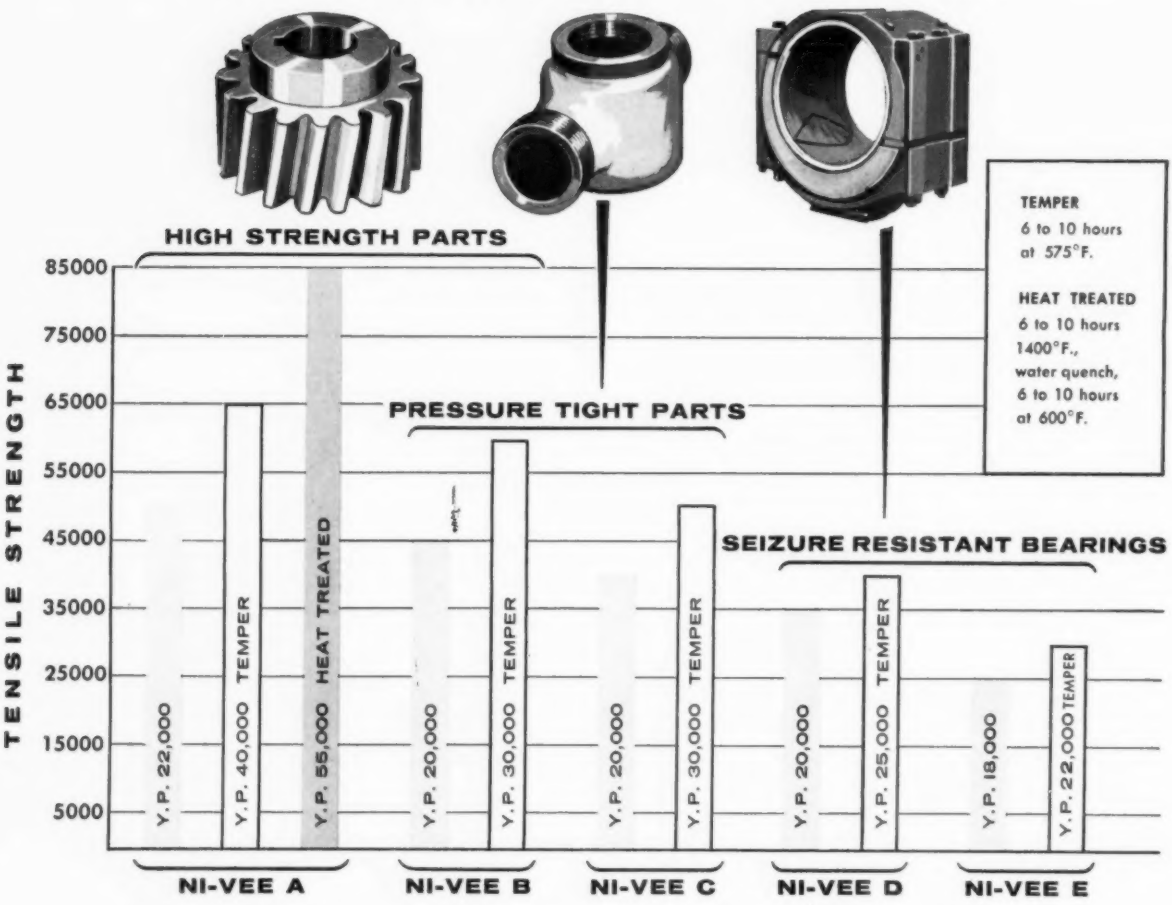
TYPICAL NI-VEE BRONZE PROPERTIES



5 high-performance bronzes

These versatile Ni-Vee alloys provide a range of properties that satisfies the requirements of most copper-base castings

The chart shows the range of tensile properties of the five Ni-Vee* bronzes and indicates the types of castings made with these alloys.

As you can see, you can satisfy the majority of your specifications for quality copper-base castings from among these five versatile Ni-Vee materials. Their "As Cast" mechanical properties – especially yield strength – surpass those of comparable G and leaded bronzes and red brasses.

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Ni-Vee extras

You can expect superior performance from all five Ni-Vee bronzes. For example. Ni-Vee B, C, D, and E (the leaded group) can be used for castings of all three classifications shown. Ni-Vee A provides extreme strength. Ni-Vee E gives you extreme resistance against galling or seizure. The low zinc group (Ni-Vee A, B, D and E) show little tendency to dezincify, insure top-notch resistance to stress corrosion. All five, of course, have the excellent general corrosion resistance of copper reinforced by a 5% nickel 5% tin content.

Helpful booklet gives complete information on Ni-Vee bronzes

"Engineering Properties and Applications of Ni-Vee Bronzes" covers tables of composition, charts on deformation, friction, fatigue, elevated temperature service, electrical resistivity, wear and other engineering data. Write for your copy today.

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GUN FIRE CONTROL SYSTEMS FOR MEDIUM A.A.A. BATTERIES

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consisting of: Fire Control Radar Set for target acquisition and for automatic tracking, optical tracker and electronic computer with a total weight of less than 3 tons.

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High mobility and quick emplacement
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Ford Instrument Co. Engineer checks air-bearing gyro for angular drift on equatorial test stand. Test can show up drift rates as low as one revolution in 40 years. Tests like this . .

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Inertial guidance systems . . . including Redstone and Jupiter

Missile launching and control order computers

Navigational and mission control systems and computers

Analog and digital computer systems

Fuzing, arming and other warhead control equipment

Plotting equipment

Nuclear systems and controls

Gunfire controls

Drone controls

A special guidance system for the Jupiter C, developed by the Army Ballistic Missile Agency, was used to launch the first U. S. artificial satellite into space.

Many components of this system were provided by Ford Instrument Co., prime contractor for both the "standard" U. S. Army Redstone and Jupiter guidance systems.

The fabulously-equipped, fantastically-clean gyro lab (above) is only a small part of the advanced research and development facilities available at Ford Instrument Co. They're used to create and produce the incredibly accurate control systems called for by modern technology in both government and industry.

And Ford Instrument's large-scale precision manufacturing facilities can turn even the most critical system requirements into working "hardware" on a quantity-production basis. Our Liaison Engineers are at your service to discuss your system requirements. 8.6

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DIVISION OF SPERRY RAND CORPORATION

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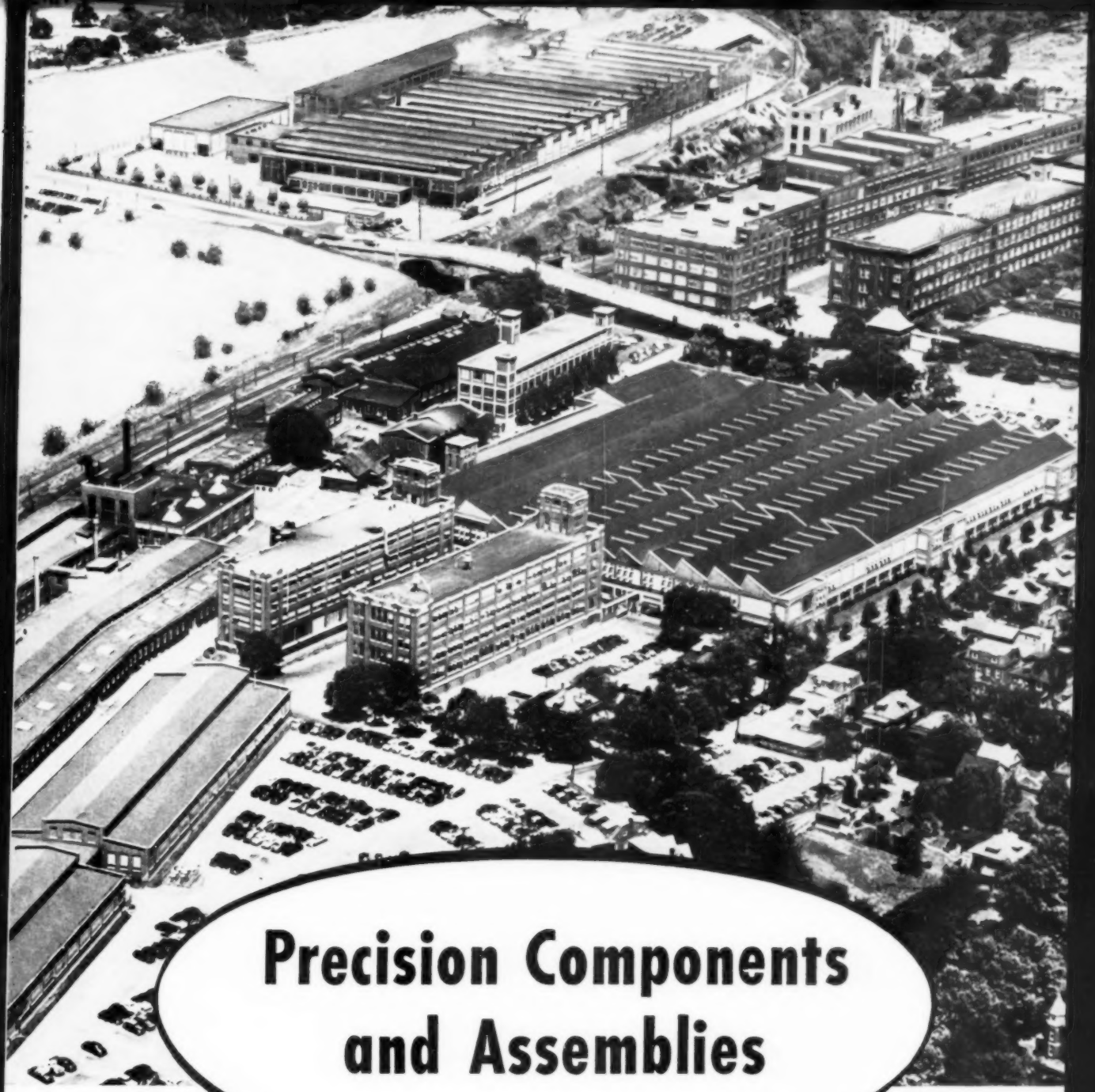

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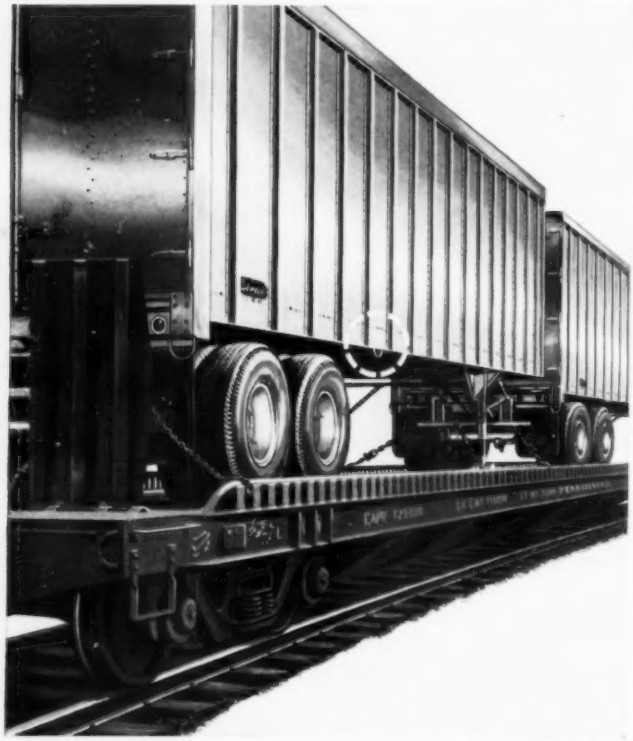
Here is "one-source" responsibility for contract work — from machines to precision components and assemblies. Textile Machine Works is a completely integrated facility. It includes one of the largest mechanized foundries in the world, a machine shop equipped with 1,250 modern machine tools, an organization of engineers and technicians trained to the most exacting standards. Textile's experience is based on 65 years of precision machine manufacture. Ask for a quotation or write for illustrated folder.

Textile Machine Works, Reading, Penna.

PARACHUTE RELEASES. The mechanical "helping hand" that automatically opens the cover of these parachutes is a fascinating, explosive-powered device of tight tolerances, housed within a hollow aluminum extrusion. It was engineered for production by Ordnance Specialties, Inc.

ROCKET HANGER BEAMS. The critical aluminum hanger beams supporting the Aero 7-D rocket launchers are Flynn extrusions. More than 50,000 of these parts have been delivered for use on Navy jet fighters such as the Banshee and Cutlass—parts that carry the payload that carry the punch.



"PIGGY-BACK" TRAILERS. The vital "backbone" of these "piggy-back" trailer bodies—the sturdy aluminum sideposts, top rails, and bottom rails—are Flynn extruded shapes. Like the ribs in an umbrella, they give strength and rigidity to the trailer shell.

THE GEODESIC DOME. Flynn extrusions form the framework for "Geodesic Domes", used by U.S. Marine Corps. These new, versatile, lightweight buildings (originally designed by R. Buckminster Fuller) were fabricated by Magnesium Products of Milwaukee, Inc.

Read what others have done ... then

Count the places in your product where Flynn aluminum extrusions can save you money

Expect to be surprised at some of the places Michael Flynn aluminum extrusions are doing an old job better—or making a new product *possible*. The contract may call for a simple, but very vital, hanger beam for an Air Force jet rocket launcher. Or, as in the case of the Geodesic Dome, Flynn extrusions may serve as the framework for an entire building.

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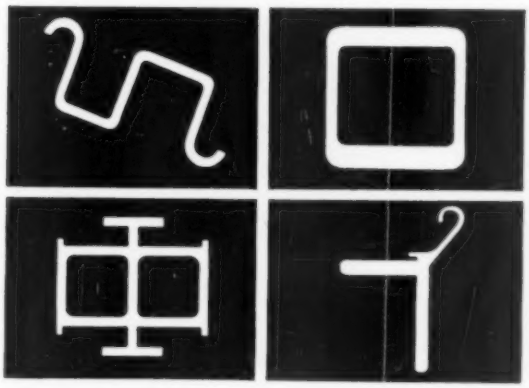

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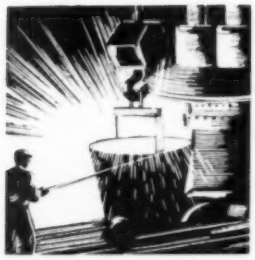

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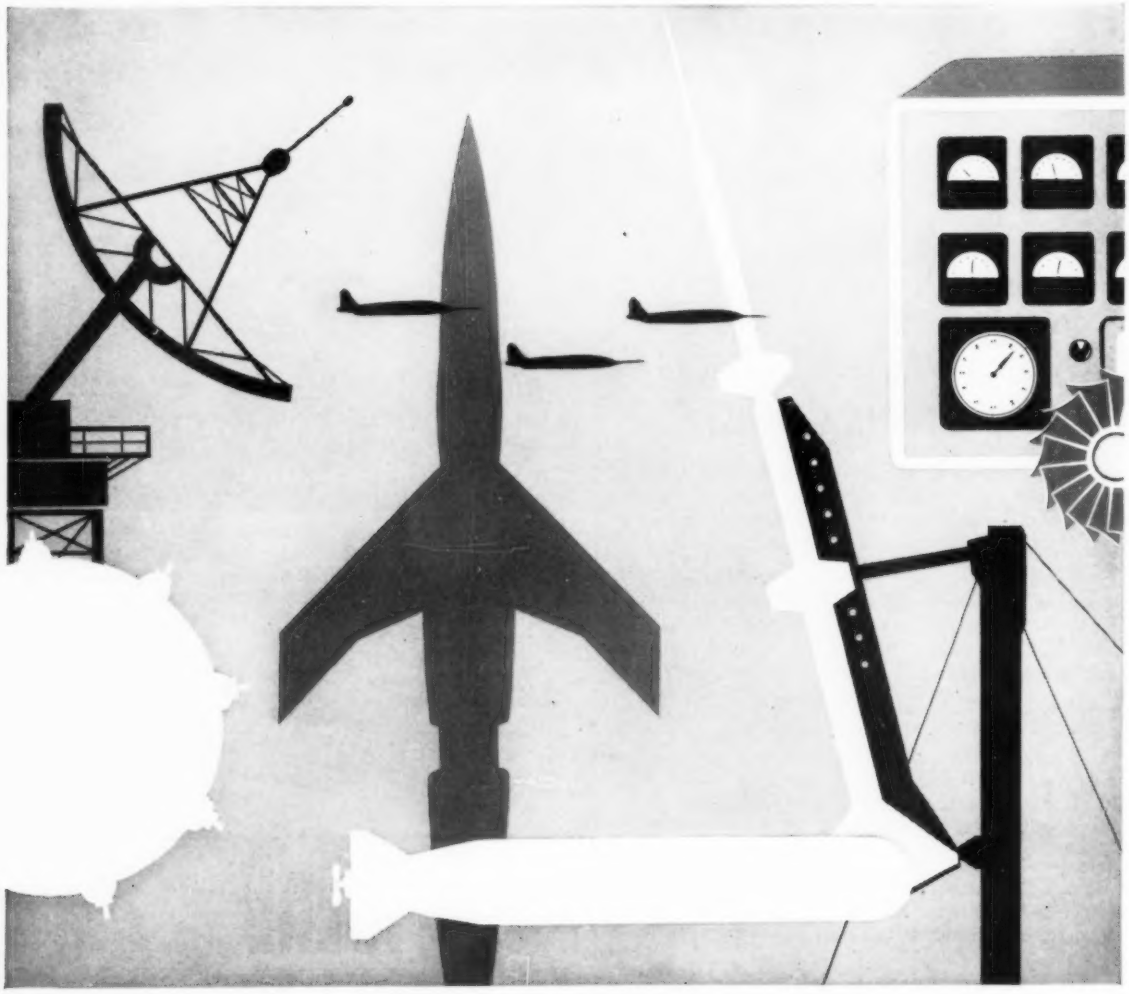

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Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Targets for Missiles

The 5-inch aircraft rocket leads high-speed missiles a merry chase

1st Lieut. Robert W. Burton, U.S.A.F.

Project Officer, Target Development Branch, Air Proving Ground Center, Eglin Air Force Base, Fla.

THE exploitation of small rockets for targets has been initiated at the Armament Division, Air Proving Ground Center, in an effort to put a reasonable target into the air for the GAR (guided aircraft rocket) missiles—both Falcon and Sidewinder—for target development has lagged years behind missile development.

At present we still have no low-cost target for the guided aircraft rocket. By precision tactics using the QB-17 and towed targets, test pilots can give the missile and fire-control system a good workout in a research and development evaluation. However, in normal training these low-speed targets present too simple a problem for the Falcon and Sidewinder, which were designed to intercept the Mach 1.5 to Mach 2.0 bomber.

SINCE towed targets in themselves are inherently limited to the speed of the tow aircraft minus about ten per cent when operating in a GAR mission, we do not expect to be able to simulate the Mach 1.5 to Mach 2.0 bomber with a towed target within the next few years. The chosen approach to overcome this speed limitation is the use of a rocket engine as the power plant for a self-propelled target. A target-carrying aircraft could carry a number of these targets and release them at altitude to exercise several interceptors.

The use of existing munitions provides a reasonably promising solution when we consider the ranges available. Two of the larger available ranges for high-altitude training in missile firing are the Tyndall Range and the Buckingham-McDill Range, both on the Gulf of Mexico (see Figure 4). In straight and level flight a Mach 1.5 target at 50,000 to 60,000 feet will remain on the Buckingham-McDill Range for 6.4 minutes and on the Tyndall Range for only 3.6 minutes.

IT becomes obvious that with these range facilities, utilization of the complete intercept picture cannot be accomplished unless the target can be slowed down and guided in a turn-around. Such a guidance could be developed, but for this development we must sacrifice simplicity, time, and money.

It is apparent that in order to solve the present training problem, certain refinements must be overlooked. A 2-stage training program can satisfy basic training requirements now. Captive missile intercepts would utilize the scramble, vector-in, and fire-control lock-on. From this plateau, live firings could be accomplished against small, properly augmented rocket targets.

The 5-inch HVAR (high-velocity aircraft rocket) is the first choice among existing munitions to serve in this rôle

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The Tu-104 power plant

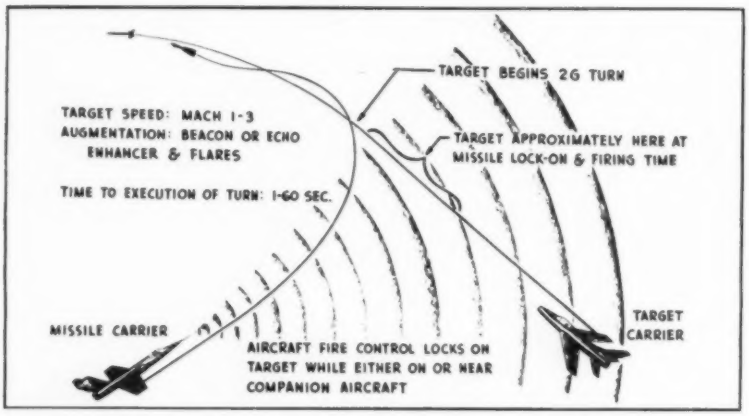

TARGET BEGINS 2G TURN
TARGET SPEED: MACH 1-3
AUGMENTATION: BEACON OR ECHO ENHANCER & FLARES
TARGET APPROXIMATELY HERE AT MISSILE LOCK-ON & FIRING TIME
TIME TO EXECUTION OF TURN: 1-60 SEC.
TARGET CARRIER
MISSILE CARRIER
AIRCRAFT FIRE CONTROL LOCKS ON TARGET WHILE EITHER ON OR NEAR COMPANION AIRCRAFT

Fig. 1. above, illustrates a typical mission utilizing a Falcon missile.

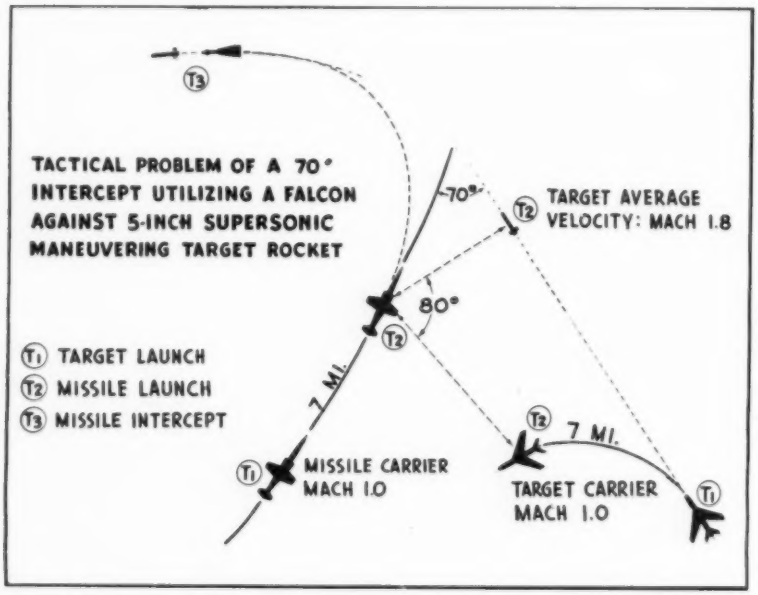


Fig. 2. Diagram illustrates approach and interception of a maneuvering rocket.

for three reasons: (1) it satisfies the minimum requirements for a GAR target; (2) the rocket is available in large quantities; and (3) it may be fired from many aircraft, both subsonic and supersonic. To present a reasonable target, the 5-inch HVAR must be modified to include radar and infrared augmentation.

The flight characteristics of the 5-inch HVAR may be varied for use in several ways in the GAR intercept problem. From trajectory data accomplished at the Armament Division, we see that a useful time of flight of approximately eighty seconds can be attained.

The average target speed may be varied easily by choosing proper launch velocities. In such a target firing, the target-carrying aircraft, at a speed of approximately Mach 1, would toss the target up at a launching angle of 30 degrees. The altitude in this firing would be 60,000 feet.

As can be seen, the target would receive a jump velocity during its one-second burning time. From this point, the target would decelerate on the uphill swing and accelerate on the downhill swing until it hit denser air. An average velocity of Mach 1.8 during useful time of flight would be attained. The horizontal distance traveled from launch would be approximately thirty miles.

These general characteristics can be altered by modifying the round in weight and balance to obtain other characteristics. The Naval Ordnance Test Station at Inyokern, for example, inserted a lead pipe between the warhead and motor of the 5-inch HVAR to give a higher mass-to-drag ratio, thus lowering average velocity and flattening out the trajectory, with no apparent sacrifice in stability.

One refinement has been included to place the missile in a natural flying environment. A 2-G turn control system has been integrated into the target to present a typical evasive action of a bomber under missile attack. This programmed maneuver is executed at a preset time depending on the characteristics desired. Since the rocket has a slow accidental roll, the maneuver results in a simulation of an aircraft rollover. A set of flippers on the warhead snaps to a fixed angle at this preset time.

THE control system is a simple one-shot action wherein a 22½-volt power supply feeds a thermal time delay through an actuator. The actuator, a safety device, closes its portion of the circuit when a 15-G longitudinal acceleration is felt by the target rocket.

Following the time delay, the circuit is completed to the squib. The squib moves a plunger, which tilts the flippers and breaks the shear pin holding the flippers along the center line. Since the point of suspension is aft of the center of pressure, this tilt is sufficient to permit air pressure to snap the flippers against the stop and hold them fixed.

A radar-augmentation section has been added between the warhead and the motor for radar fire-control tracking and the radar homing GAR. Visual and infrared augmentation by means of flares seems to be generally acceptable until a better infrared source is available.

We have now seen the operational performance and the control system of this 5-inch supersonic maneuvering target rocket. Let us look at the minimum GAR target requirements in two types of tactical operations. The first and less sophisticated would utilize one aircraft with an optical lock-on system capable of carrying both the infrared GAR and the 5-inch HVAR. The F-89J and F-89H as well as the F-104 would be suitable aircraft.

In this one aircraft mission, the target rocket and the infrared homing GAR would be carried under opposite wings (Fig. 3). Infrared augmentation of the target would be accomplished with flares. When in the desired position, the pilot would launch his target

rocket which would fly in straight and level flight until some preset time when it would execute a 2-G turn in some direction. As the target proceeds in the straight and level portion of its trajectory, the GAR locks on and the pilot may fire at will. In such a mission a missile count-down time and time of flight totaling approximately thirty-five seconds would be required.

The more sophisticated and realistic utilization of the 5-inch target rocket would require radar and visual augmentation. Infrared augmentation would be necessary if the IR homing Falcon were used. Intercept angles up to 80 degrees could be used depending on the speed ratio of the target to interception. In these missions where two aircraft, a missile carrier and a target carrier, are used GCI (ground-controlled intercept) or SAGE would set up the problem. Figure 1 shows the general tactical problem and Figure 2 presents the particular tactical problem for a 70-degree intercept.

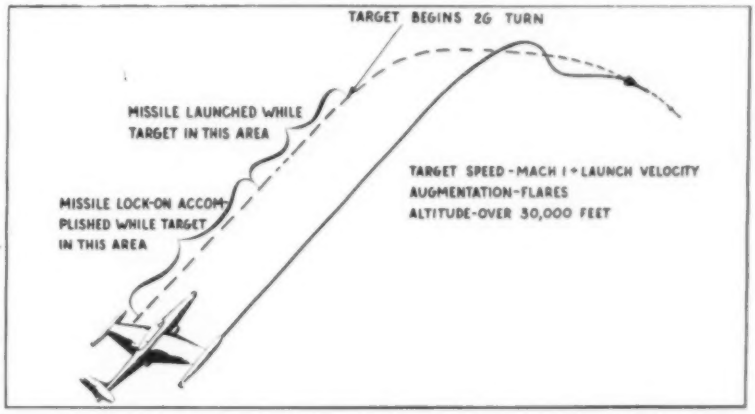

TARGET BEGINS 2G TURN
MISSILE LAUNCHED WHILE TARGET IN THIS AREA
MISSILE LOCK-ON ACCOMPLISHED WHILE TARGET IN THIS AREA
TARGET SPEED - MACH 1 + LAUNCH VELOCITY AUGMENTATION - FLARES ALTITUDE - OVER 30,000 FEET

Fig. 3. Typical mission utilizing an infrared homing guided aircraft rocket.

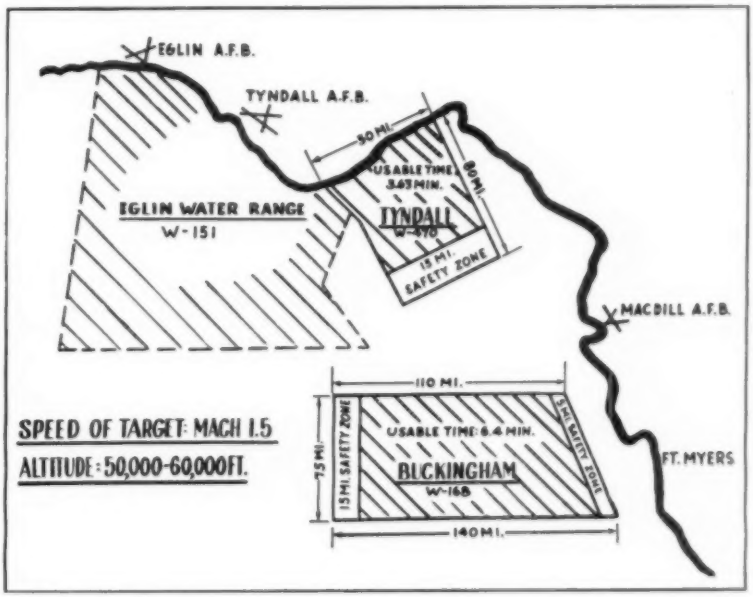


Fig. 4. The Gulf training ranges used in testing air-to-air missile interception.

IN a training operation, a short time before the missile carrier closes in on the target carrier the pilot in the target carrier will activate the radar-augmentation unit in one of his target rockets. As the missile carrier closes in on the target, it locks on the activated target rocket beneath the wing or body of the companion aircraft. The radar augmentation produces a sufficiently large signal to overshadow the radar return of the target-carrying aircraft. After lock-on, the pilot of the missile-carrying aircraft advises his companion to launch the augmented target rocket.

In this first phase of the attack, the target rocket proceeds on its tossed-up trajectory with visual and/or infrared augmentation flares burning. During this time the pilot of the missile carrier must determine visually whether he is locked on the target rocket or his companion.

This problem may be solved with relative ease. For example, if the attacking pilot observes he is headed forward of the target he may be sure that he is following the correct lead-collision course. If pointed behind the rocket, it is probable that he is locked on his companion. In such an emergency a mission abort could be accomplished easily. In a semiautomatic fire-control system, as in our present aircraft, where the trigger must be pressed for missile launch, no problem exists. In the automatic systems, mission abort could be effected by switching from radar track to radar search. The required useful flight time of the basic target would be approximately one minute.

With a sacrifice of sophisticated refinements, a realistic low-cost target may be put into the air for today's use with the Falcon and Sidewinder missiles. By using an F-100 as a target carrier, six of these one-minute targets could be launched. Thus by the judicious use of this target carrier, we could accomplish as many as six GAR attacks against one launch aircraft.

By this method of using a target carrier to carry multiple targets, we could effectively side-step the expensive development and use of a multipass target of longer duration.

EDITOR'S NOTE.—Vice Adm. John H. Sides, Director of the Weapons Systems Evaluation Group, outlined the important relationship between supersonic missiles and targets in a paper published in the July–August 1957 issue of ORDNANCE. He wrote:

"The fact that such missiles also can be fired upward at targets many thousands of feet above the firing aircraft also can influence the very designs of our interceptors by letting us optimize their performance for altitude where they are most efficient."

Powder Metallurgy Abroad

A survey of the work being done in this field in European countries reveals good progress in both Germany and France and a stage of development in Russia at least equal to that of the United States

Henry H. Hausner

POWDER metallurgy in Europe has gained considerably in importance during the last five years. It is not possible to talk about powder metallurgy in Europe in a general way, but such discussion must be divided as to Western Europe and Eastern Europe, with subdivisions by individual nations within each division.

The leading countries in the western part of Europe are England, Sweden, Austria, and Germany. England's great interest in powder metallurgy was indicated by the well-arranged London Symposium in December 1954, where fifty-four papers were presented covering practically the entire field of powder metallurgy. Most of the papers were on a practical or engineering level, and almost no papers were presented on theories of compacting and sintering, although some impressive theoretical work is going on, especially at the U. K. Atomic Energy Authority installation at Harwell.

THE application of powder metallurgy in Sweden grows steadily. Three companies lead in the field: Hoeganaes, Husqvarna, and Glissa, and we are not surprised to find iron-powder metallurgy, especially, highly developed in Sweden. Theoretical work, however, is lacking, and Professor Hedvall of Gothenburg, who contributed so many important theories on solid-state reactions on previous occasions, retired two years ago.

Dr. Kiessling who contributed to the theory of cermets, concentrates his activities at the Atomenergi A-B on reactor materials, but uses powder-metallurgy methods for the production of reactor fuel elements.

Mr. Hausner is vice-president of the nuclear engineering division, Penn-Texas Corporation, New York, N. Y. This paper was presented before a meeting of the Powder Metallurgy Committee of the A.O.A. at Joliet Arsenal, Ill.

Most of the theoretical work in the western part of Europe is done in Austria and Germany. In Austria the pioneer of powder metallurgy, Professor Huettig, was involved during the last few years especially in the theories of powder grinding. Professor Nowotny of the Technical University in Vienna, was concerned with the theoretical aspects of hard metals, and most of the practical work was done on a large scale at the world-famous Metallwerk-Plansee in Reutte under Dr. Kieffer's direction. The Plansee Proceedings of the meetings in 1952 and 1955 are, in my opinion, the most important books on powder metallurgy published in recent years.

The first powder metallurgy meeting in Western Germany was held in June of 1957 at Aachen. Theories of compacting were extensively discussed at this meeting, and I refer especially to the paper by Dr. Naeser, known for his development of the powder rolling process, on "Mechanical Activation of Powders." The seventeen papers presented at this meeting were of high caliber.

In the Netherlands, powder metallurgy is well studied and applied. However, it is done by just one company—the Philips Company in Eindhoven. Theoretical work and powder-metallurgy fabrication of tungsten and molybdenum and of high-temperature materials and magnets are on the highest level.

TEN years ago powder metallurgy in France was of a rather low level, although the work of Professor Neel on sintered iron magnets opened new aspects in the powder metallurgy of magnetic materials. Today powder-metallurgy production grows fairly rapidly in France, although very little theoretical work in the field has been done during the past few years. An exception is Eudier's work on "activated sintering." In a recent discussion with Professor Chaudron in Paris he indicated to me his great interest in the theories of sintering, however, less for its application in powder metallurgy than as a tool for research in solid-state reactions.

Powder metallurgy is just at its beginning in Italy, Spain, and Belgium. During the powder-metallurgy meeting in Rome in October 1956, the chairman, Professor Corsini, stated:

"Powder metallurgy in Italy is far from having reached the standard of importance to which it is entitled when compared with the development that has been achieved in other countries. It

is therefore not surprising if the results that we are now going to report are still far below expectations.

"Theoretically our technicians have kept themselves informed of the progress achieved abroad but have been handicapped on the production line by the resistance to change, in fact we may roughly estimate a gap of ten years between our present stage and the peak reached by other countries. This is largely due to the limitation of funds made available to military organizations, to the insufficient budget allotted to our universities for studies and research, and to the mental attitude toward taking any pioneering risks." This statement is valid also for Spain and Belgium.

AT the powder-metallurgy symposium in Rome, thirteen papers were presented, of which five papers were submitted from other European countries or from the United States. Powder metallurgists from foreign countries were highly welcomed in Italy as "stimulators."

Entirely different conditions exist in the eastern part of Europe. Powder-metallurgy research, development, and production behind the Iron Curtain are highly developed in the U.S.S.R. and Eastern Germany; less in Czechoslovakia, Poland, and Hungary, with only a minimum of work being done in Yugoslavia. In a recent report which I submitted to the Atomic Energy Commission in Washington on powder metallurgy in the U.S.S.R. I stated that from all the information available to me "I am inclined to draw the conclusion that powder metallurgy in the U.S.S.R. is at least at the same stage of development as it is here in this country."

THE famous Russian metallurgist, Dr. V. S. Rakovskii, some time ago gave a talk on the "Basic Problems of Powder Metallurgy in the Light of the Decision of the Nineteenth Congress of the Communist Party of the Soviet Union." In his talk he mentioned that progress in many technical branches cannot be achieved without powder metallurgy. He discussed further the great number of theoretical studies on compacting and sintering by a number of Soviet scientists, and criticized some of the theories very sharply:

"The main trouble lies in the fact that until now there has been no single theory of sintering which completely covers all aspects of this important process. Each scientist studies miscellaneous separate aspects of sintering, and there is as yet no general theory. Individual theories have blanks and defects, and this is true even of the most thorough and complete theories by Soviet scientists."

Dr. Rakovskii stated further: "We must note that modern methods of research are as yet very little used in theoretical work on powder metallurgy. We refer to the electron microscope methods, the radioactive isotopes, the phase analysis—all of which are widely used in many branches of general metallurgy."

Nevertheless, from the study of the Russian literature and from a discussion which I had with Professor Meerson of Moscow during the Atoms for Peace Conference in Geneva in 1955, I am inclined to say that Russian metallurgists probably work more on the theory of powder metallurgy than do scientists in any other country of the world. I mention this because, in my opinion, the technology of powder metallurgy will improve only if we do more theoretical work.

HYDROSTATIC compacting for production of turbine blades has been extensively studied in Russian government laboratories. Cermets, in general, especially metal and metal-oxide mixtures, seem to play an important rôle. The Russians are using powdered-metal parts for agricultural equipment and electronic instruments, automotive, aircraft, and nuclear engineering applications. They are using low-cost sintered iron-graphite bearings for conveyors in place of expensive ball and roller bearings—the iron powder being obtained by atomizing molten cast iron.

Metal chips—shavings—are being made into watch mechanism parts by powder-metallurgy techniques, with considerable saving of metal. Russian engineers are testing ultrasonic methods to get powder alloys in microcrystalline form and thus improve their properties. They are applying radioisotope and spectroscopic techniques to study the mechanism of diffusion during sintering.

Dr. Rakovskii stated with respect to powder metallurgy: "Our science should become the first one in the world!" I believe that we should do everything here in this country to avoid a "sputnik" in powder metallurgy.

Professor Meerson also informed me that he is working on the powder metallurgy of nuclear reactor materials, and his paper on the "Powder Metallurgy of Thorium" was well received at the Geneva Conference.

MANY excellent powder metallurgists are located in the eastern part of Germany. I refer to Professors Sauerwald, Skaupy, Eisenkolb, and others. When they learned that a meeting on powder metallurgy was planned in Aachen in West Germany they immediately scheduled a similar meeting in Eisenach, Eastern Germany, which took place two weeks before the meeting in West Germany. They wanted to make their meeting larger and better than the West German meeting, with the result that the West German powder metallurgists enlarged their program further to beat East Germany.

The Eisenach meeting was attended by metallurgists from U.S.S.R. and the Iron Curtain countries, as well as from England, France, and West Germany. However, it is my impression from a discussion with Professor Eisenkolb, whom I met in Aachen, that powder metallurgy in East Germany is rather on an expanded engineering level and less of a theoretical nature than it is in West Germany or in the U.S.S.R.

IN Czechoslovakia powder metallurgy seems to be on a high level but also less theoretical in nature than in the U.S.S.R. Several weeks ago I received the proceedings of a Czechoslovakian symposium on powder metallurgy in which not less than 63 papers were presented and described.

During my European consulting trips in 1955, 1956, and 1957, I met many powder metallurgists from various countries. It is their general opinion that powder metallurgy at the present time does not progress enough in Europe because not enough theoretical work is being done. For years the European powder metallurgists looked to the United States for progress and admired the large amount of theoretical work done here.

Today this admiration has decreased considerably, mainly because of the fact that during the last few years very little theoretical work in powder metallurgy has been done in our country.

Cooling Electronic Gear

A comparatively simple, lightweight system utilizing water as a coolant has been developed to dissipate the heat build-up of high-speed flight both for manned vehicles and supersonic missiles

Giles J. Strickroth

IT is 70 degrees below zero 80,000 feet above the earth, but an airplane streaking through this cold, thin atmosphere at Mach 3 churns up friction enough to destroy any electronic circuit that is left unprotected. Just beyond Mach 2 the skin temperature is 150 degrees centigrade. At a speed of Mach 5 above 100,000 feet of altitude, it jumps to over 400 degrees, or about 800 degrees Fahrenheit.

This heat build-up at high speed, known as aërodynamic heating, plagues the builder of aircraft and missiles. It spells particular trouble for the electronic designer whose products contain temperature-sensitive materials that burn up in supersonic flight.

The armed services are seeking new materials that will enable electronic equipment to work despite heat. It is a large order, handicapped by great expense and a short supply of information. The affected parts are complex and delicate and their variety is endless. We are not yet certain when we will be able to beat the heat by building immunity into the electronic component on a broad scale. We do know the day is far off.

MEANWHILE, electronic gear must be cooled. Up to the Mach 2 region we've met some success by passing artificially cooled air over the components. There we are halted. So hot is our air "coolant" beyond Mach 2.5 that ordinary means of cooling no longer can lower its temperature to the point where it will do any good.

Mr. Strickroth is manager of the electronics and controls department, the Martin Company, Baltimore, Md.

Our work with cooling systems has shown, however, that there is a much better coolant than air. It is water, a fluid that cannot be heated beyond its boiling point without pressurization, a coolant that tops all others in its ability to absorb heat. We have found that an electronic chassis enclosed in a can of water remains at an essentially constant temperature while the temperature outside the can is raised from 150 to 426 degrees centigrade. The system operates indefinitely depending on the size of the water supply.

This water-evaporative method thus brings electronic cooling to the Mach 5 region. In so doing, it overcomes other major limitations of the air-cycle and evaporative-cycle methods now in use.

A typical air cycle system bleeds hot compressed air from the jet engine. An intercooler transfers the heat to ram air tapped from the current flowing past the ship. The cooled air is ducted to the electronic equipment after passing through an air-expansion turbine. At a sacrifice of compression, ram air can substitute for the bleed air—a useful variation in vehicles not powered by jet engines.

A later development is the "insulate and isolate" technique. The airframe or component is insulated to keep heat out and the internal heat generated by the equipment is removed by a heat sink, such as jet fuel. Fuel, unfortunately, has a rate of heat absorption that is unequal to the task.

More recently, attention has turned to the evaporative cooling cycle. A fluid, either air or liquid, is circulated through the electronic components and then through a heat sink such as water. A vapor-cycle system is added at higher temperatures. That, of course, calls for a compressor, an expansion valve, and an evaporator.

THE trend toward compounding of complexity is unmistakably clear. Together with complex apparatus go the penalties of added weight, added bulk, and added expense—plus a greater probability of malfunction. Air bled from a jet engine cuts down on propulsion efficiency, and more fuel must be carried. It takes power to operate the high-speed rotative equipment. Extensive ducting networks, moreover, are common to all these systems.

From experience with these systems we drew two fundamental conclusions. First, most of the cooling load above Mach 2 is carried by the water boiler. Secondly, efficiency is served by placing the heat sink close to the components that must be protected. These principles are the basis of the evaporative system for cooling electronic equipment, developed by the Martin Company.

The system is simply this: An aluminum can is mated mechanically to any electronic chassis. The top of the can

is recessed to match the contour of the tubes. The coolant is water, introduced through a filler port. Heat converts the water into steam which escapes through a vent. Loss of water during negative gravity conditions or inverted flight is prevented by a check valve in the vent. Another valve controls boiling pressure.

External aërodynamic heat is blocked by the water jacket, which cannot be heated beyond 100 degrees centigrade. The internal heat generated by the electronic equipment is transferred to the boiling water by metallic fingers in contact with both the tubes and the inner shell of the water can.

THE system has proved its worth in more than a year of tests. A water container was designed for a single-tube amplifier circuit and the components were heavily instrumented to indicate surface temperatures at vital points. The apparatus was placed in an oven where temperature was stepped up from 150 to 426 degrees centigrade. At the highest temperature, approximately 95 per cent of the heat was external—a fair simulation of the proportion between aërodynamic and internal heating.

Through this range of temperature, no portion of the amplifier circuit rose more than 10 degrees. In terms of flight speed this means that the circuit passed from Mach 2 to approximately Mach 5 at an essentially constant temperature. Water consumption was 4 ounces, or a quarter pint after 2½ hours of operation at Mach 2 and 15 minutes at Mach 5 temperature. Further tests with multiple tube specimens yielded even more satisfactory results.

It should be noted that the exteriors of the test assemblies were not insulated although the evaporant would thereby be conserved. In an airborne installation the length of cooling time gained by the use of insulation would have to be weighed against the weight penalty the insulation would exact.

Of further significance is the fact that the system has not been pushed to its limit. The oven temperature was held down to keep the instrumentation wiring from burning up.

Satisfied that this evaporative system would do its cooling job, we studied how it might be applied to the various types of electronic equipment used in high-speed aircraft and missiles. We considered its effect on electronic, thermal, propulsion, and aërodynamic requirements. It was compared with the best existing cooling equipment in weight, volume, fuel requirements, and drain on the propulsion system.

IN weight, the conventional systems fare well at low speed. But as the environmental temperature rises, these systems must take on more and more complexity, which adds pounds. Water cooling offers a substantial weight dividend at higher speeds in both manned vehicles and missiles. It adds about 10 per cent to the weight of the unprotected components, but the elimination of ducts and associated cooling equipment brings the net weight saving to thirty-five or forty pounds per kilowatt hour.

The volume of the unprotected black box is increased slightly by the Martin system. In manned aircraft it frees about sixty-four cubic feet that would be occupied by the ducts and equipment of a conventional system. Somewhat less volume would be saved in a missile.

As for adapting the system to electronic equipment, advantages are gained from the assurance that circuits will remain at virtually the same temperature level. There is a consequent saving in time for circuit design, manufacture, and installation.

Because the cooling system is independent of bulky and inefficient ducting, it is entirely self-contained. Electronic components can be placed wherever they are needed—on the wingtip, for example.

Less compensation for temperature fluctuation need be designed into electronic circuitry. The components can be laid out functionally without compromising the most logical arrangement in favor of low-temperature spots. The only concern is that the high heat sources, like tubes, be completely enveloped by the evaporant fluid.

All currently used electronic packaging techniques are feasible—conventional wiring, printed wiring, modular stacked wafer design, and CNI modular-type packaging.

The cooling package is manufactured by ordinary production techniques from thin sheet stock. Standard bench test methods are employed. Its modular arrangement permits contouring for efficient use of space.

The dollars spent for electronic cooling can be considered from several viewpoints. Take the high cost of aircraft weight. If we assign an arbitrary manufacturing rate of $20 a pound for our typical Mach 3 airplane, the evaporative system would trim $12,000 to $13,000 worth of weight from each flight vehicle.

Simplicity will sharply reduce the manufacturing and development cost of the new cooling system. At a time when other systems are leaning toward more and more high-speed rotative equipment, small units seldom cost under $2,000 in quantity production. Their development can easily run into the $35,000 bracket—and high-speed vehicles have as many as three of these expensive units.

For such reasons we are confident that the water-jacket principle gives electronic equipment a new lease on life at speeds through Mach 5. It will, in fact, prolong component life, for by decreasing the surface temperature of a typical vacuum tube from 260 to 140 degrees centigrade, we extend the operating life of the tube from 500 to 1,300 hours—a 260 per cent increase.

THE system is as simple as a can of water. It reverses the trend toward complexity, and saves weight, volume, and expense. It bleeds no air from the jet engine and needs no power supply or ducting network. Such efficiencies are reflected in improved flight performance.

"There is a much better coolant than air. It is water, a fluid that cannot be heated beyond its boiling point without pressurization, a coolant that tops all others in its ability to absorb heat. We have found that an electronic chassis enclosed in a can of water remains at an essentially constant temperature while the temperature outside the can is raised from 150 to 426 degrees centigrade. The system operates indefinitely depending on the size of the water supply.

"This water-evaporative method thus brings electronic cooling to the Mach 5 region. In so doing, it overcomes other major limitations of the air-cycle and evaporative-cycle methods now in use."

Russian Jet Engine

A description of the power plant of the Soviet Tu-104 aircraft

Blaine M. Miller, Jr., and Richard E. Stockwell

RECENTLY we had the unusual opportunity to enter Russia for the purpose of seeing the annual air show. The show, unfortunately, was canceled, but we did get an opportunity to see some other things having to do with Soviet aviation. One was the engine that powers the Tu-104 jet airplane. This engine was shown to us at the Air Museum, the House of Aviation, near the Zhukovsky Air Academy in Moscow.

The engine is not an outstanding powerplant, and displays none of the sophistication common to Western engines. It is a simple, straightforward design, of very large diameter. The front end of the casing measures about 48.5 inches across, on the outside from rim to rim.

The engine has eight compressor stages, an annular burner section with fourteen fuel nozzles, and either a single or a 2-stage turbine. We were able to see only one stage with seventy-eight blades of relatively thick chord. Similarly, the compressor blades were very large and very wide. Judging from the bolt heads that showed through, there are fifty-six nozzle vanes ahead of the turbine. (See photo of engine below.)

Both Mr. Miller and Mr. Stockwell are with the General Electric Company—Mr. Miller as an engineer at the Flight Propulsion Laboratory and Mr. Stockwell as a management information analyst, Aircraft Gas Turbine Division.

It was not possible to see beyond the nozzle vanes to determine whether or not there was another turbine wheel inside the engine, though if there is one the Russians have pulled off some mechanical magic because the combustion system section behind the compressor is so short as to all but preclude another turbine stage.

In addition to fourteen low- and high-pressure fuel nozzles in the combustion system, we noted seven ignition wires indicating seven spark plugs. The engine has six struts each in the front frame and tail cone.

The engine's bearing system seemed conventional in that there were three main bearings located in the front, mid, and turbine frames, with an overhanging turbine wheel. The compressor casing is split both axially and radially and is made of aluminum alloy. The combustion casing, of steel alloy, is only twenty-five inches long.

Compressor stator vanes are bolt-mounted through the casing, and the thirty-six inlet guide vanes are actuated from the nose gear. There was a power take-off from the front struts, numbers one, four, and six. Deicing bleed air from the seventh stage of the compressor is piped along the port side through a large black metal tube into the front frame struts and the inlet guide vanes.

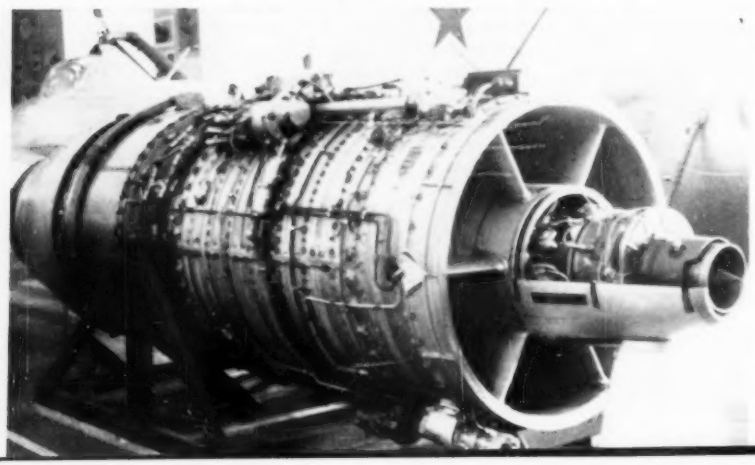
A SIMPLE steel band around the middle of the engine between the third and fourth stages may be tightened or released to shut or open a series of ports to let out stall bleed air. Once the engine is up to a speed past the compressor stall point, the band may be pulled tight hydraulically to close the ports.

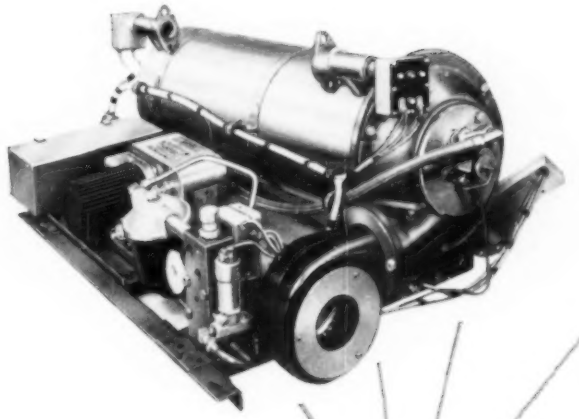
The engine was quoted to us as being in the 7,000 to 8,000-kilogram-thrust class. From other reports we have heard on this engine, we believe that 15,000 pounds of thrust, the lower figure, is about right for it. It has a high specific fuel consumption, something over 0.9 pounds per pound of thrust per hour.

One unique feature of the engine is a small gas turbine in the nose cone which is used to start the main powerplant. The small centrifugal-flow gas turbine is started with an electric motor. Once it is up to speed, at which point it delivers between 60 and 100 horsepower, it is in some manner engaged to the forward end of the compressor shaft to turn it.

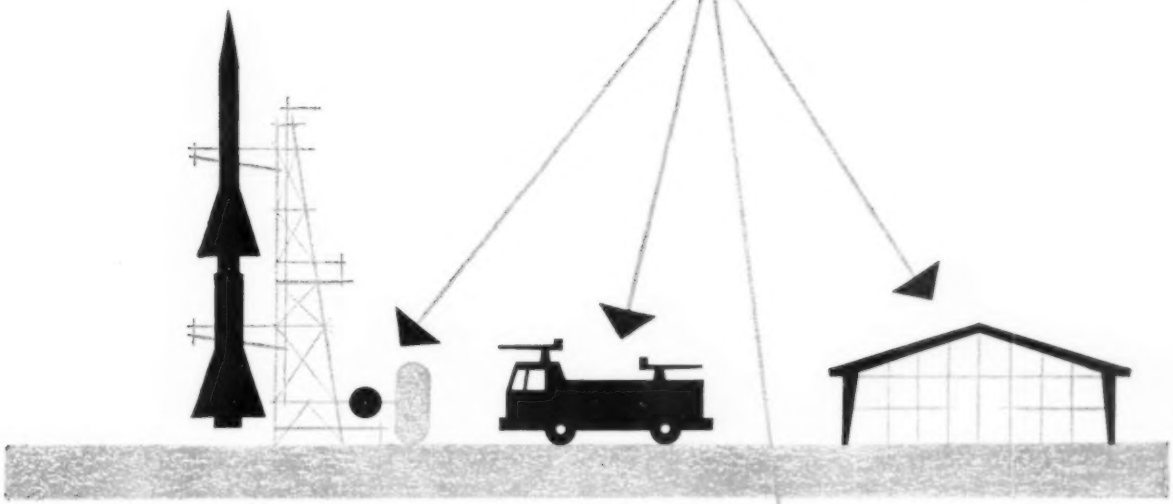
The engine in the Tu-104 is designated the AM-3, which is the designation, we were told, of a construction bureau named "Aviation Mikulin."

The AM-3 jet engine that powers the Russian Tu-104 transport.





reliable heat for ground support



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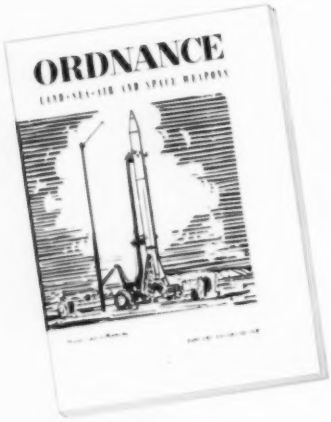

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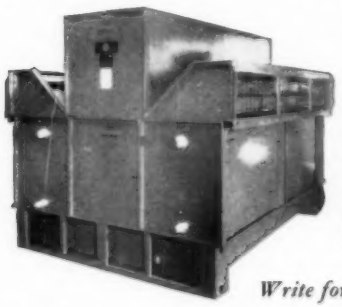

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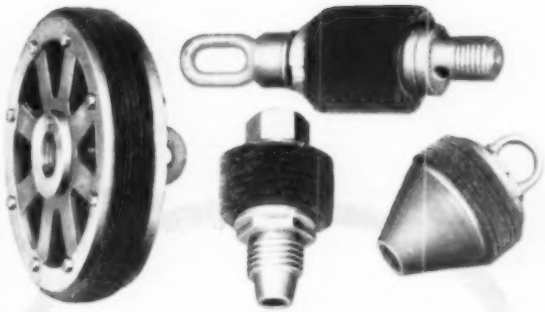

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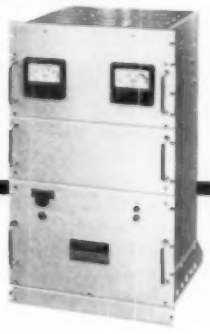

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MAY-JUNE 1958

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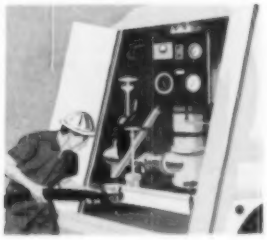

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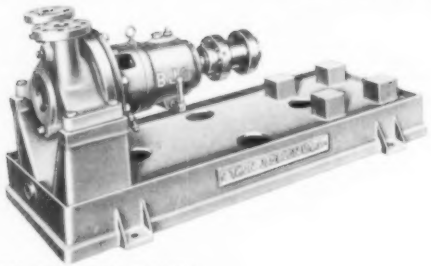

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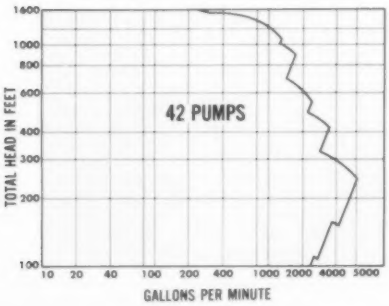

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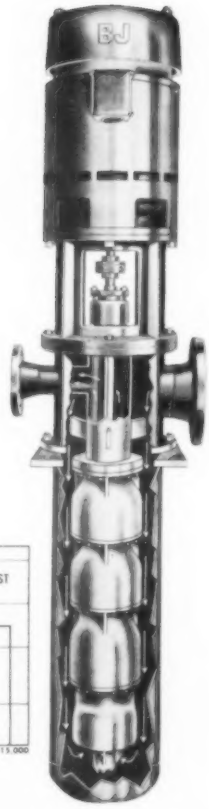

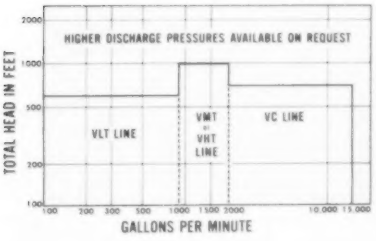

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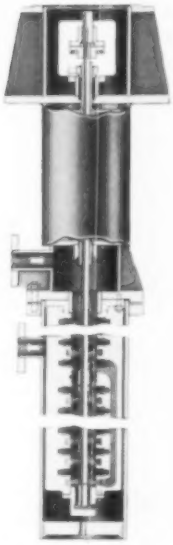

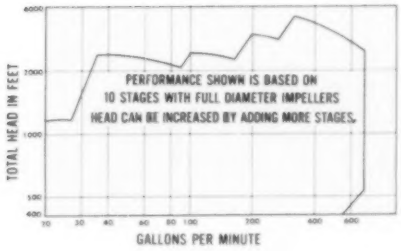
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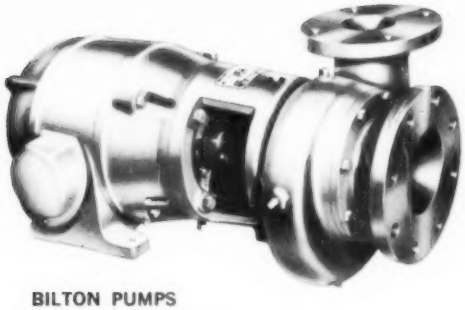
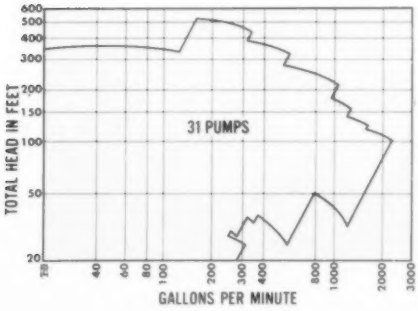


BILTON PUMPS

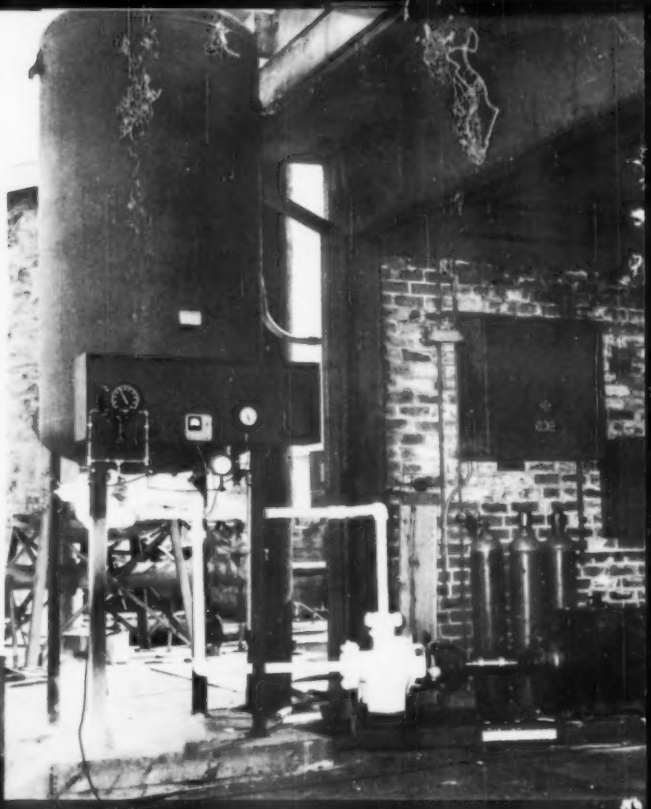
A self-contained horizontal motor-pump with Lo-Temp mechanical seal. Due to the close-coupled design and construction, Bilton Pumps are light and compact, require less space in mobile installations, are more economical, easier to maintain. Size is usually limited to 60 hp maximum.

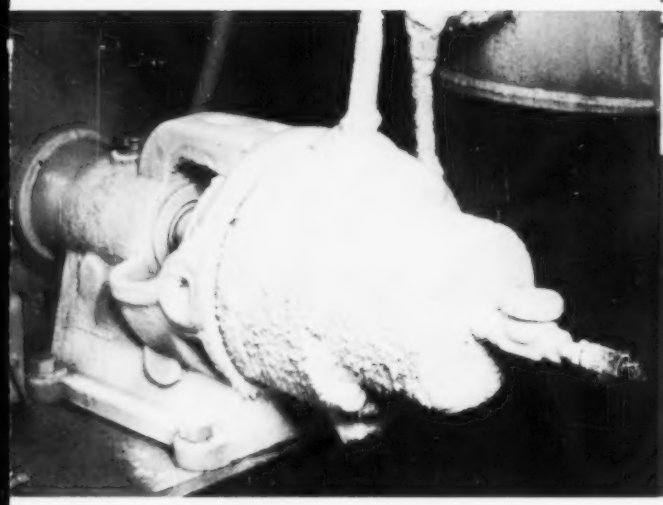


SPECIAL CRYOGENIC PUMPS

Pumping requirements for cryogenic fluids cannot always be met by the BJ standard line of Cryogenic Pumps due to chemical properties, toxicity, space limitations or other unusual conditions.
With such problems, Byron Jackson engineers will be glad to work with you to develop the pump for the job, and can place over three-quarters of a century of pump engineering knowledge at your disposal.

Thoroughly tested and qualified for CRYOGENIC service





Permanent Byron Jackson cryogenic pump test facility — used to improve the design of pumps and seals and to investigate the effect of suction pressure on pump cool down time.

Close-up of Mechanical Seal tester with cryogenic seal. This seal was developed to make standard BJ Process Pumps readily adaptable for pumping of low-temperature liquids.

Some of the BJ Cryogenic Pump customers

American Messer Corp.
Big Three Welding Supply
Canadian Industries Ltd.
Cambridge Corp.
Celanese Corp.
Corps of Engineers (Cape Canaveral)
Dept. of Navy
Dow Chemical
Fluor Corp., Ltd.
Grace Chemical
Hayes Aircraft Corp.
H. L. Johnson Co.
L'Air Liquide
Liquid Carbonic Corp.
Mississippi River Chemical Corp.
Spencer Chemical
St. Paul Ammonia Products, Inc.
U.S. Air Force
Wall Cryogenics Inc.

COMPLETE INFORMATION *is now available . . . including specific performance data for the various lines of BJ Cryogenic Pumps. Write for Engineering Bulletin Section 1700.*

BJ SINCE 1872

Byron Jackson Pumps, Inc.

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